FLIGHT and The AIRCRAFT ENGINEER

FIRST AERONAUTICAL WEEKLY IN THE WORLD : FOUNDED 1909

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The Outlook

One Month's Work——

STATISTICS compiled from official communiqués bring to light some interesting facts about the work of the R.A.F. during the month of October. In spite of unfavourable weather conditions—no operations were possible on five days and eleven nights—the Royal Air Force made 195 attacks on 81 Axis targets. Seventeen of these were directed against ten military and industrial targets in Germany itself, Bremen and Cologne being the principal objectives, while Nurnberg had the heaviest.

Enemy ports in occupied territory received attention on 59 occasions, among the 27 targets being Brest, Boulogne, Ostend, Dunkirk, Calais, Cherbourg and le Havre. In his broadcast talk on November 6th, Group Captain Helmore stressed the fact that the Russian air force was being employed almost exclusively on tactical duties (except for a few raids on Berlin), the Royal Air Force relieving it of the necessity to carry out strategical bombing. That, at the moment, is the form which our collaboration has taken, not counting the R.A.F. wing in Russia nor the British aircraft delivered to the Russian air force.

In the Mediterranean, Benghazi, Tripoli and Bardia were the targets during October, the numbers of the attacks being 21, 13 and 12 respectively. On the other side of the Mediterranean operations against Italian ports and bases were intensified, and Naples was visited five times during the month.

One feature of the work of the R.A.F. during October was the offensive carried out against Axis shipping. Bomber, Coastal and Fighter commands were extremely active. The types of vessels sunk included tankers, *Flak* ships, patrol vessels, armed trawlers, E-boats, lighters and warships. Effective attacks were also made on barge concentrations. In the North Sea and off the Atlantic coast 71 ships are known to have been sunk or damaged, and 30 sunk or damaged in the Mediterranean bring the total to more than 100. From May to October the Axis fleet was reduced by some 533 vessels, 332 in European waters and 201 in the Middle East.

Truly the Royal Air Force has not been idle, and its attacks are steadily gaining in volume and intensity.

——and the Cost

THAT casualties in attack should be heavier than those in defence is inevitable. Yet in proportion to the damage done to the enemy our own losses during October cannot be held to be excessive, much as we must mourn them. Compared with the war on the eastern front they are insignificant. On what may be termed the home front, that is to say, in all offensive operations against the enemy, including fighter sweeps, fighter escorts of our day bombers, and in defence of this country, the R.A.F. destroyed 83 enemy aircraft in the daytime and 17 at night. Our own losses during all these operations were 143 aircraft, 71 during the day and 72 at night. In the Middle East we destroyed 21 aircraft and lost 46, and on the Russian front the R.A.F. wing destroyed three enemy aircraft without loss. To finish the balance sheet for October the total result may be summed up as 101 enemy vessels and 119 aircraft for the loss of 189 of our own aircraft. That, we venture to suggest, is a satisfactory result, and it does not take into account the damage inflicted by our bombers, which is known to have been great.

These figures do not, of course, include casualties arising from accidents to returning aircraft. There must have been many nights, for example, on which the weather deteriorated badly while our bombers were away, and it is logical to assume that a certain number of aircraft were damaged on landing. There is, however, good reason for believing that our own losses of that nature are more than matched by corresponding losses to the enemy.

Italian Shadow Factories

THAT it will in the future be necessary to keep an eye on the Italian aircraft factories seems to be indicated by the news that during October a German mission composed of technical representatives of the German Air Ministry and of such well-known firms as Heinkel, B.M.W., Askania and Arado visited the Fiat aircraft works at Turin. The purpose is not difficult to guess, and it seems obvious that this famous Italian firm is about to become a shadow factory of the German aircraft industry. Some time ago it was announced that an agreement had been concluded whereby the Breda concern of Milan had arranged to build Junkers Ju. 87s. The Italian Government is said to have undertaken to finance the expansion of the Italian aircraft industry, and to have earmarked 2,800 million lire for the purpose.

The Amazing Hurricane

THERE seems to be no end to the uses to which the Hurricane can be put, and put successfully. It originally appeared, about six years ago, as an eight-gun fighter. Early in the war it did nearly all the fighter work in France. Then it was announced that it was being used for convoy work in the Atlantic, catapulted from naval vessels. Hard on the heels of that announcement came the details of the Mark II, which carries as alternative armament twelve .303 machine-guns or four 20 mm. cannon. And now it has been fitted with bomb racks and has already given a good account of itself as a low-level surprise bomber. It has not been stated whether or not additional armouring has been installed, but it seems that in any case the surprise element is likely to be more important, although protection against machine-gun ammunition would appear to be essential.

H.M.S. *VICTORIOUS* AT SEA : One of our four new aircraft carriers, of the *Illustrious* class, the *Victorious* is 753ft. long, 95ft. in the beam and has a displacement of 23,000 tons. Her maximum speed is 30 knots and provision is made for a complement of 1,600 men. In addition to multiple pom-poms and other small arms, sixteen 4.5in. dual-purpose anti-aircraft guns are fitted in twin turrets. H.M.S. *Victorious* took part in operations at Petsamo and her aircraft assisted in the pursuit of the *Bismarck*.

BACK HOME : Vickers Wellingtons of the Middle East Command arriving back home at dawn from a raid on Tripoli.

British Aircraft Reaching Russia : "Annihilated" Reds Counter-attack Near Moscow : Possible Air-borne Attack on Caucasus : R.A.F. Contend with Bad Weather

SIR WALTER CITRINE has spoken of seeing Hurricanes being unshipped at Archangel "hand over fist." Stalin, in his invigorating speech to the Soviet peoples, announced that the supplies promised them by Britain and America were arriving and he referred to the growing strength of the Red Army and the superiority of the Red Air Force over the *Luftwaffe* in morale and prowess—in everything, that is, except sheer numbers—but expressed the hope that, before long, Hitler would be compelled to fight on two fronts. By this he no doubt meant a second front in the West, which could only be created by the despatch of another expeditionary force of British and Allied land forces against German and/or German-occupied territory across the Channel and the North Sea.

SPOTTED DOG : An Me 109 wearing mottled camouflage to harmonise with the desert scrub.

There is, of course, a section of public opinion in this country which has been clamouring for some such direct attack, at once, in the belief that the depleted German army (Stalin assessed their losses in Russia at 4,500,000 men) could now be overwhelmed, and that the *Luftwaffe*, which has already been compelled to give up raiding this country on any serious scale because the Russian fronts demand all its dwindling strength, would not be able to give the usual support to their ground troops.

It is not within our province to express an opinion on such a matter, which, we feel, is best left to those in full possession of all the facts, but one may take considerable heart from the almost negligible progress which the Germans have been able to make during the past few days in their drive towards Moscow. Even Dr. Goebbels' optimistic department seems to have stopped "pursuing the beaten enemy" on the Moscow front in view of the quite outrageous impediment being successfully placed in the way of Hitler's triumphal march to the Kremlin by an already "annihilated" Russian army.

With the Russians thus apparently holding the invaders firmly at bay on the north-west section of their front (and even driving the panzers back in successful counter-attacks at several points), the main interest shifts for the time being to South Russia, where the Germans are making desperate efforts to invest Sevastopol and Kerch in the Crimea and to penetrate into the Caucasus across the Kerch Straits and by way of Rostov.

It is probably in the Kerch Straits approach, which would give a quicker

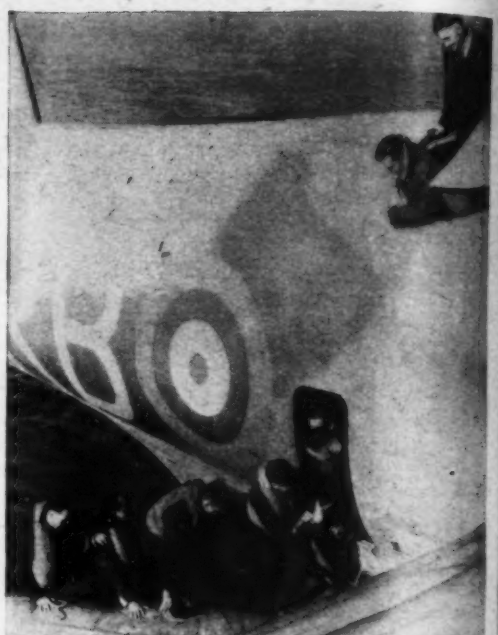
access to Caucasian oil fields at a time when the Germans must be badly needing oil as soon as they can lay their hands on it, that use will again be made of air-borne troops on a large scale. Doubtless the Russians would follow up their scorched earth policy with a parallel "burnt boats" plan should the Germans reach the shores of the Straits, and thus it might largely fall to the *Luftwaffe* to transport any advance attacking party over this narrow stretch of water. The Russian Black Sea Fleet will, of course, have to be reckoned with, as well as their air force, and it remains to be seen (at the time of writing) if the Germans can face again the terrific losses in men and aircraft similar to those incurred in taking Crete. Much—or nothing—may happen before these words reach the readers of *Flight*, such is the speed of modern warfare.

R.A.F. Keep It Up

IN the meantime, the R.A.F. in the West continue to pound away at German war industries, communications and shipping to such good purpose that the enemy is compelled to maintain in this theatre a fairly strong force of fighters which he can ill afford to spare from the Russian fronts. In the air, at any rate, Hitler *is* being forced to fight on two fronts, and the measure of relief afforded to the hard-pressed Soviet pilots and air crews must be considerable.

This maintenance of pressure by the R.A.F. has been achieved during the past month under particularly unfavourable weather conditions. In fact, October's weather was considerably worse than the average standard for this particular month; so much so that it was quite impossible to operate on 15 days and 12 nights. Yet the actual effort, in terms of bomb-weight dropped, was nearly double that of October, 1940, when the weather was far more favourable, and the explanation of this apparent anomaly is a most gratifying one. It is the result of the greatly increased strength of Bomber Command during the past year, both in the numbers of machines and in the average bomb-load per machine. Naturally the enormous bomb-carrying capacity of our latest four-engined aircraft such as the Stirling, the Halifax and the American Flying Fortress has been responsible for the latter increase.

During the past week there have been reports of "continuous bad weather," yet Bomber Command have attacked enemy convoys off the Friesian Islands and harbours in Occupied France, industrial districts in the Ruhr and Rhineland and the docks at Ostend and Dunkirk; Coastal Command Hudsons have bombed ships off the Dutch and Norwegian coasts, the docks at St. Nazaire and an oil factory at Bergso; while Fighter Command have continued their offensive



SEA RESCUE: When a British bomber was forced to alight on the Atlantic the main dinghy failed to inflate, and the whole crew of six had to manage with a two-seater. They were later picked up by a Sunderland of an Australian squadron. The crew are seen boarding the flying boat from their dinghy.

OVER THE WAVES: A Fairey Swordfish just airborne after being catapulted from *H.M.S. Malaya*. The position of the elevators is interesting.

daylight sweeps over Northern France, attacking gun positions, ammunition dumps, goods trains, barges, stores dumps and other ground targets.

On last Friday night bad weather, added to the German defences, caused the R.A.F. grievous losses. The Bomber Command sent out some 300 machines, including Stirlings, Halifaxes, Wellingtons and Whitleys. The main targets were Berlin, Cologne and Mannheim. The weather changed suddenly for the worse after the bombing fleets had taken off, and those which were sent against Berlin suffered most. The cold was intense, and crews which returned had almost heartrending stories to tell of how they suffered, of icicles hanging from the oxygen mask of a pilot, of the intense agony of a navigator when he touched one of his instruments wearing only his silk gloves, and so on. Naturally, the aircraft themselves got iced up, and evidently many of them became uncontrollable. Several of them are known to have wandered far off their course, and some—we do not yet know how many—were actually forced down by the weather. As a result, 37 of our machines, or over 10 per cent. of those which started out, failed to return to their bases. It is a consolation that no doubt many of the crews have survived as prisoners of war, but the loss to the Bomber Command is not light.

The following day, Saturday, also produced some astonishing and not very agreeable results. Some fighters made daylight sweeps on their own over France, and Hurricane bombers secured hits on a factory at St. Pol. Other fighters escorted Blenheim bombers. During the day we lost 15 fighters, one of the pilots being saved, and only destroyed four enemy fighters. None of our day bombers was lost. It is difficult to suggest an explanation of this result.

Undismayed by the losses on Friday night, the Bomber Command returned to the attack on Saturday night, and the German munition works at Essen suffered severely in consequence. Docks were also attacked. The price paid that night was eight bombers missing, which cannot be accounted unduly high for the results achieved.

The Hurricane Bomber

MENTION was made above of Hurricane bombers. This is a new development. It is not a mere copy of the German Panther, or Messerschmitt carrying bombs, which was used in the final stages of the Battle of Britain last year. The Panthers were a confession of the impotence of regular German bombers to achieve their results in the face of the defence of the R.A.F. Fighter Command. The Panthers dropped their bombs from a height and then used their speed to escape. The Hurricane fitted with racks to carry bombs is quite a different weapon, intended for surprise and low attacks on ground targets. It should make a useful complement to the new Hurricane armed with four cannons. It resembles the Panther in being able to revert to its fighter rôle after it has dropped its bombs. In time, both new versions of the Hurricane should be very useful in supporting a British army by attacking the ground troops of the enemy. We all look forward to the day when the R.A.F. will be able to play that part.

In the Middle East, too, the R.A.F. and the S.A.A.F. have kept up the good work, bombing airfields at Berka, Castel Benito and Derna, while aircraft of the Fleet Air Arm successfully raided other targets. The Italian convoy destroyed by the Navy was first seen by a Maryland. Hostile aircraft afterwards fruitlessly attacked our ships with torpedoes.

ENEMY AIR LOSSES TO NOV. 8th.

	Over G.B.	Over Continent	Middle East
Nov. 2	0	0	13
" 3	0	0	0
" 4	0	0	2
" 5	0	0	1
" 6	0	3	1
" 7	1	4	1
" 8	0	4	0
	1	11	18

Totals: North and Russia, 5,544; Middle East, over 2,157.

BRITISH AIR LOSSES TO NOV. 8th.

	Over G.B. A'crft.	Over Continent: B'brs.	Ftrs.	Pilots	Middle East A'crft.
Nov. 2	0	0	4	4	2
" 3	0	0	0	0	0
" 4	0	1	2	2	3
" 5	0	8	1	1	2
" 6	0	1	3	3	0
" 7	0	37	1	1	0
" 8	0	8	15	14	3
	0	55	26	25	10

Totals: North and Russia, 3,009; Middle East, about 463.

LE DERNIER CRI: The Hawker Hurricane in its latest form is a fighter-bomber. In addition to the two bombs—which are carried on external streamlined racks—it still has ten machine guns for offence or defence.

HERE AND THERE

Dollars from Scholars

MR. WINANT, the American Ambassador, has just handed over to the R.A.F. Benevolent Fund a cheque for 3,165 dollars (£635 at par) collected for Britain by the masters and students of his old school—St. Paul's, Concord, New Hampshire.

The head, the Rev. Norman B. Nash, left the allocation to Mr. Winant, and he chose the R.A.F. Benevolent Fund to be the recipient of the School's generosity.

More Bombers for the N.E.I.

THE Netherlands East Indies Air Force will soon be reinforced by a number of North American NA-40B bombers. As these machines have a flying range of 2,700 miles without refuelling, they will be a valuable addition to the N.E.I.'s defences.

These particular bombers are said to be similar to the medium bombers built for the U.S. Army Air Forces. They are believed to be an improved version of the NA-40A, which have two 1,600 h.p. engines, an all-up weight of 24,000 lb., and a top speed of 310 m.p.h. It is further understood that the contract for these machines for the N.E.I. amounts to about £6,000,000.

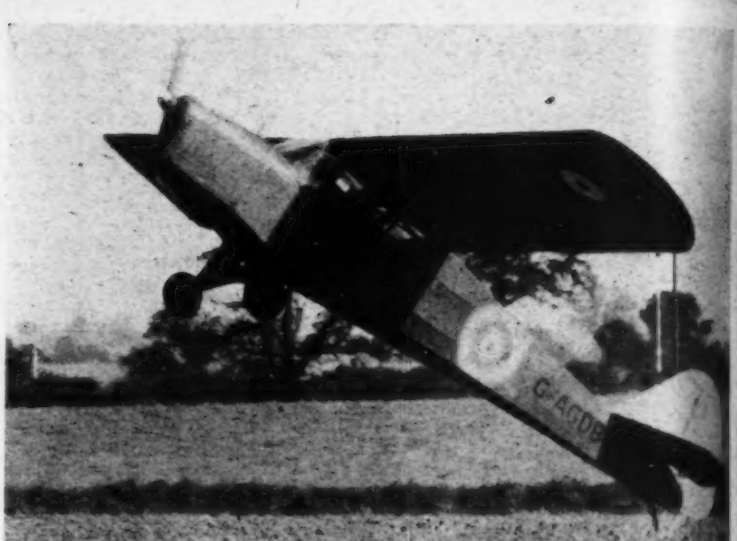
Many Thanks, Rhodesia

WARM thanks to the government and people of Southern Rhodesia for the part they are playing in the Empire Air Training Scheme was paid by Sir Archibald Sinclair, Secretary of State for Air, at a recent luncheon in London.

Sir Archibald was entertaining the High Commissioner for Southern Rhodesia, Mr. S. M. L. O'Keeffe, and Air Commodore C. W. Meredith, A.O.C. Rhodesian Air Training Group, and he referred not only to the excellent quality of the reinforcements which were reaching the R.A.F from their training schools, but to the excellence of the arrangements for the reception of pupils, who included not only men from the United Kingdom and members of the British Commonwealth of Nations, but also personnel of the air forces of Allied nations.

"The people of this country," said Sir Archibald, "are particularly grateful for the warm and generous welcome which our men have received from the people of Southern Rhodesia who, like ourselves, are firmly resolved to fight this war through to victory."

Air Comdre. Meredith is at present visiting training units of the R.A.F.



TAYLORCRAFTY: A spectacular take-off of the latest Taylorcraft monoplane, which is fitted with a new 100 h.p. engine. A remarkable angle of climb is claimed for it, and the landing speed remains at about 35 m.p.h.

A Change of Name

A CHANGE of name of the Stearman Aircraft Division of Boeing Airplane Company to "Wichita Division, Boeing Airplane Company," is announced by P. G. Johnson, Boeing President, and J. E. Schaefer, Vice-President and General Manager of the Wichita Division.

The change makes for simplification in the name structure of the organisation, and consistency of name in the handling of government contracts.

Lapsus Calami

THERE is an inaccurate reference in *John Bull*, page 7, issue of November 1st, to a letter in the pages of *Flight* of May 15th last by Mr. W. J. Lord, of Coventry (not "H. J. Lord" as stated by *John Bull*). As a result of the commentary made by *John Bull*, in which that journal described our correspondent as "production manager of one of the biggest aircraft concerns in Britain," a number of people have associated with the remarks the name of Mr. L. P. Lord, who will be known to the majority of our readers (but to comparatively few of those of *John Bull*) as the works director of the Austin Motor Co., Ltd.

In view of the injustice made possible by the fact that a non-technical contemporary has jumped to a wrong conclusion, we are asked to emphasise that Mr. L. P. Lord was not the author of the letter which appeared in our columns in the issue of May 15th, nor of another letter last week. Moreover, he entirely dissociates himself from the commentary made by *John Bull*.

Self-supporting Air Mail

CANADA'S main air mail service is now carrying its own weight financially, according to a recent Post Office report. Mail loads have increased beyond the estimates even of hopeful forecasts of a few years ago.

By a surface means, an exchange of letters between the Atlantic and the Pacific coasts involves a period of 11 or 12 days, while air transmission can accomplish it in a matter of three days, only two of which are occupied in transmission and the other left for receiving and answering correspondence in offices and homes. Loads carried by T.C.A. aircraft have increased to the point where the machine leaving Toronto at midnight for Western Canada carried an average daily mail load of 635 pounds in July.

St. Louis Calling

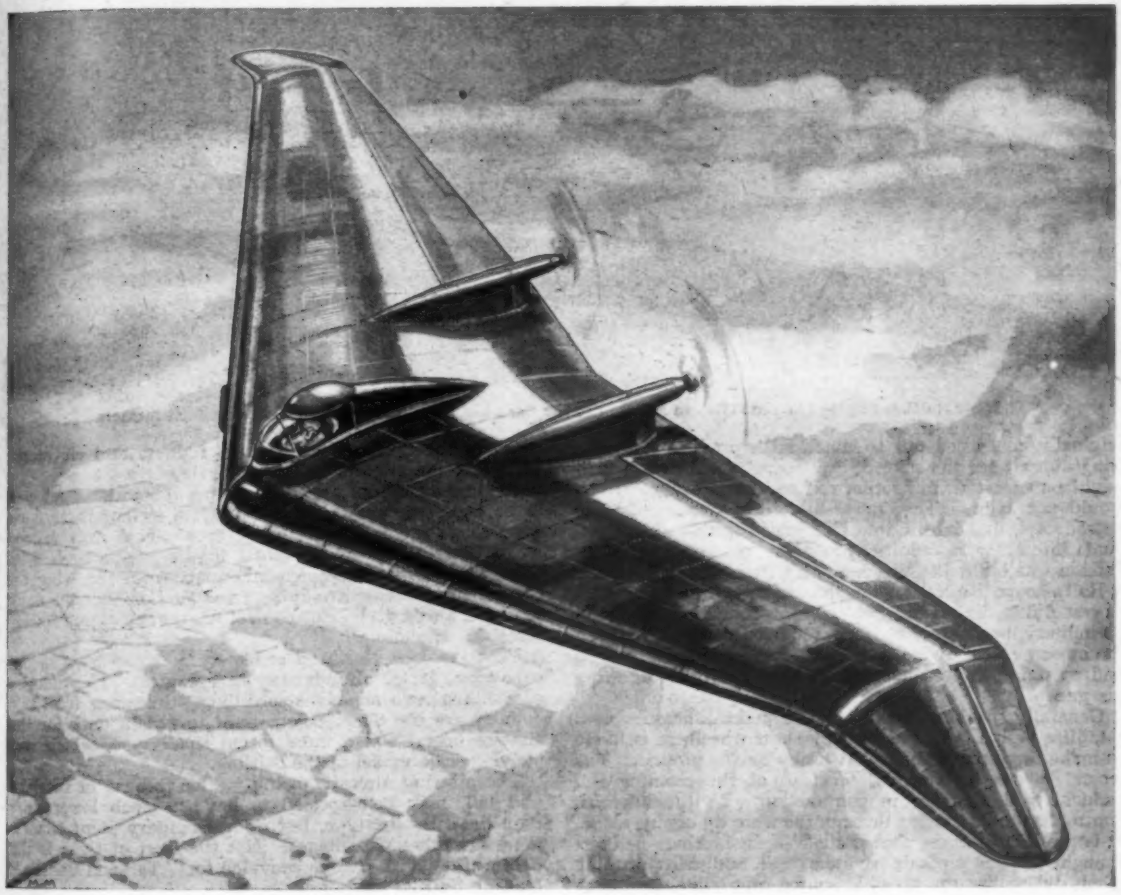
DURING the presentation of the film "A Yank in the R.A.F." at St. Louis, Missouri, the father of an American pilot serving in a fighter squadron of the R.A.F. spoke direct from the theatre to his son in England. For a few minutes this real-life "Yank in the R.A.F." was in contact with his folk back home, 4,000 miles away.

When the first request came through it was found that the pilot was on twenty-four hours' leave "somewhere in London." Clubs, theatres, and hotels were combed for the young American. A few minutes before midnight he was located at his hotel, and rushed to the telephone just as the performance was starting, which, of course, would be about 7 p.m. in America.

ADVERTISED GOODS

THE fact that goods made of raw materials in short supply owing to war conditions are advertised in this journal should not be taken as an indication that they are necessarily available for export.

THE TAILLESS AGAIN



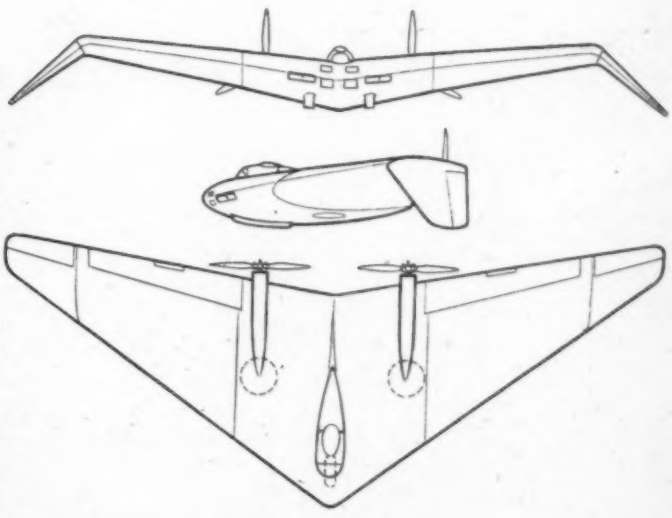
Max Millar's interpretation of the new Northrop tailless monoplane in flight. The general arrangement drawings below were based on the patent specification.

Jack Northrop's Latest Baby : Successful Test Flights by Scale Model : The Problem of Control

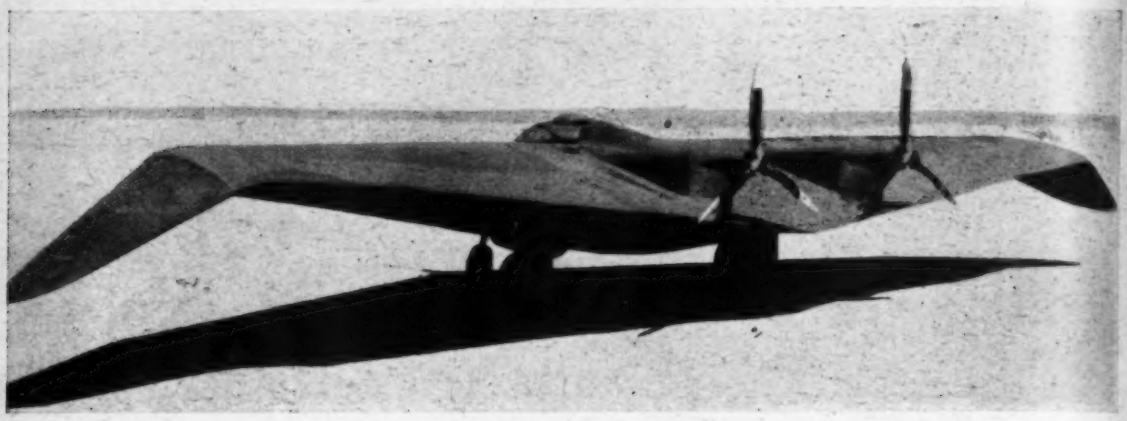
THE late Professor Hugo Junkers is generally credited with being the first man to visualise an aircraft entirely without tail surfaces. He took out a patent somewhere around 1910, and he called the type a *Nurflügel*. The literal translation is wing-only, but many years ago *Flight* suggested "all-wing" aircraft as a better term, being descriptive in the way that "all-eyes" and "all-ears" are descriptive.

What prevented the original Junkers design from being developed in the early days of flying was the fact that, to accommodate passengers, the wing chord had to be very great, some 30-35ft., and aircraft engineering had not then progressed so far that such a project could be made a reality.

German glider designers continued to toy with the idea of the all-wing principle and several were built, as well as a few low-powered light planes. No great success was, however, achieved. In this country the champion of the tailless aircraft was Capt. Geoffrey Hill, now Professor Hill. He was



THE TAILLESS AGAIN



The new Northrop flying scale model. In addition to the fixed tail wheel there is a nose wheel which retracts.

originally concerned not so much with producing an all-wing aircraft for the sake of any reduction in drag which might be expected, but rather did he aim at a wing which would not spin. The first Hill tailless was named the Pterodactyl, and later Capt. Hill joined forces with Westland Aircraft. In addition to light planes, a military version was built, the Westland-Hill Pterodactyl V. With a Rolls-Royce Kestrel engine this machine did quite a lot of test flying, but it did not go into production, although its military merits were obvious, the most noteworthy being the amazing field of fire provided for the rear gunner, who had an uninterrupted hemisphere through which to swing his gun.

Generally speaking, there are two main difficulties with a tailless design. The necessarily short wheelbase is likely to make the aircraft somewhat tricky on the ground. The second relates to controls. Instead of the elevator and rudder, used alone or in conjunction with the ailerons, control has to be exerted through the wing tip organs alone. It is possible to argue that if the Wright brothers had not thought of the separate rudders, tail and wing-warping (they did realise the possible source of trouble, and they interconnected the warp and the rudders), and if the Farman brothers had not adopted ailerons in place of the warping wing, we might have evolved a sensible form of control much earlier.

Two-control Flying

In the tailless design there does seem to be a chance of attaining the ideal of a two-control aircraft. In fact, the type almost seems to be impossible without it, since the wing tip surfaces must of necessity perform more than the single function of the aileron. They have to serve as elevators and rudders also. How that function is best achieved is a problem which is still a long way from being settled, but it may be that the American designer, John K. Northrop, has made yet one more step towards the solution in his new flying scale model.

The Northrop tailless monoplane was patented some time ago and nothing more was heard of it until recently, when a small machine with two engines of about 120 h.p. each was test flown, apparently with a good deal of success. The machine seems to have two "flat" engines buried in the wing. They drive pusher airscrews, and thus to that extent the new Northrop is very modern. Another modern touch is a "four-wheeled tricycle" undercarriage.

But the most intriguing puzzle about the new Northrop flying model is its aerodynamic controls. The plan view shows the pronounced sweep-back common to all tailless aircraft. But, in addition, Jack Northrop has tilted his wing tips down at an angle of roughly 45 deg. The thought which comes to mind immediately is that this has been done so that the control surfaces on the trailing edges of the tips can act both as rudders and elevators. That they are ailerons as well is obvious.

Trailing edge flaps are fitted farther inboard. That was to be expected, but an unusual feature is that these flaps seem to be fitted with trimming tabs. That may merely mean that for the experimental flights it was desired to have some form of adjustment, apart from the wing tip control surfaces; or it may be an indication that the flaps are used also for elevator control or, perhaps more likely, for "tail trimming."

That the new Northrop is merely a flying scale model of a much larger aircraft may be accepted. The practice of building such models is spreading. Instances from this country are the Short Scion, built to obtain data for the Empire boats, and a more recent small type, which was a flying scale model of the Stirling.

The all-wing aircraft, owing to the absence of fuselage and tail, may be expected to have a much lower drag than the orthodox type, but from a military point of view there are other advantages. Not the least of these is the field of fire which can be provided for "Tail-end Charlie" (except for the pusher airscrews!). Some of the disadvantages have already been indicated. There are others. For instance, the short overall length of a tailless means that control surfaces act on short lever arms. The moment of inertia is low, of course, but the stowage of military load is likely to be somewhat exacting, and bombs could not be spread much in a fore and aft direction without causing a serious change of trim when they were dropped.

By using two engines, several advantages are secured. The pilot obtains a very good view forward and laterally, although forward and downward the wing gets in the way (in the Northrop, windows in the leading edge help matters). But one problem arises as to what happens to a tailless when one engine stops. Although the airscrews can be placed close together, and consequently the offsetting of the thrust be reduced, one wonders if there is enough rudder power to hold the aircraft against the running engine.

Target for This Week

LAST week we pointed out to our readers some of the uses to which old copies of *Flight* can be put in order to assist the Ministry of Supply to collect that 100,000 tons of waste paper which is asked for. Air gunners and anti-aircraft gunners need preliminary ground training, and for that cut-out targets made of a paper base are used. One ton of old copies of *Flight* (it will amount to about 6,500 copies) will make no fewer than 36,000 of these targets. So when debating with yourself whether you have really finished with that old copy, remember that it will make more than five of these targets. They might be the means of saving a gunner's life by giving him that little extra practice.

Twelfth of the Second Series

FRIEND or FOE?

Two Partners on Sea Patrol : Lerwick and Consolidated—31

SARO LERWICK. Single, cantilever tail-unit. Tall fin and rudder. Backswept leading-edge to tailplane and round tips. "Stinger" power-operated gun turret.

HERE are two flying boats which might easily be mistaken for each other were it not for the marked difference in their tail designs. In this case both of them are "on our side," but one can readily imagine a variety of circumstances in which it might not be sufficient to know only that the aircraft was a friendly machine, but imperative to establish its exact identity.

The Saro Lerwick and the Consolidated 31 have a great deal in common where external appearances are concerned. Both mount a pair of radial engines on their high cantilever wings and both have hulls of such a depth as to make them look shorter than they actually are, and apart from their tails, the only really obvious difference is that the Lerwick has fixed cantilever stabilising floats near the wing-tips whereas the American flying boat has retractable floats which fold inwards towards the engine nacelles. This feature, of course, will always be discernible from an underneath rear view.

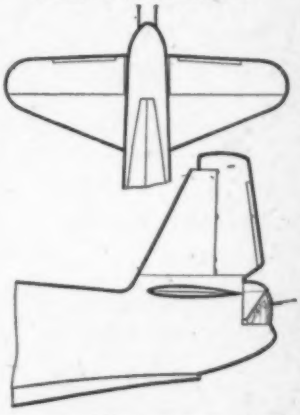
Aft of amidships, however, there is a sharp difference in design both of the hull and the tail surfaces, the Lerwick having a single tail unit and the Consolidated 31 twin fins and rudders—characteristics which make differentiation instantly certain without necessarily bothering about any other details. But spotting is not just a matter of differentiating between two somewhat similar machines; it also demands the ability to identify any machine without the convenient help of comparison, and for that reason familiarity with all the salient visible features remains essential to the spotter.

Considering the Lerwick first, it will be seen from the accompanying illustrations that the second step of the hull is well back under the tailplane and that, in order to accommodate the rear power-operated gun turret, the hull preserves a substantial depth right to its extremity. The large single fin and rudder has a straight taper to both edges and a flat, square-cut apex. It will also be noticed that the horn-balance of the rudder leaves a small break in the line of the leading-edge just below the apex and that the rudder is shelved upwards at the foot of its trailing-edge just above the gun turret. The cantilever tailplane has a backswept leading-edge, round tips and straight trailing-edge.

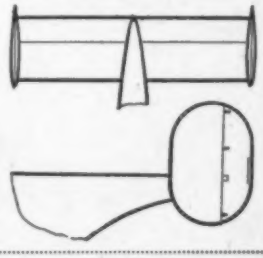
Turning to the Consolidated 31, the hull, which has a straight back, tapers up very abruptly in a concave curve from the second step to the tail, the second step being about half-way between the first step and the tail; the latter has no "stinger" turret and is pointed. The cantilever tailplane is rectangular and has the twin fins and rudders outrigged on the tips. These vertical surfaces are symmetrical, parallel-sided ovals projecting equally above and below their point of attachment; the rudder portion constitutes about one-third of the total area.

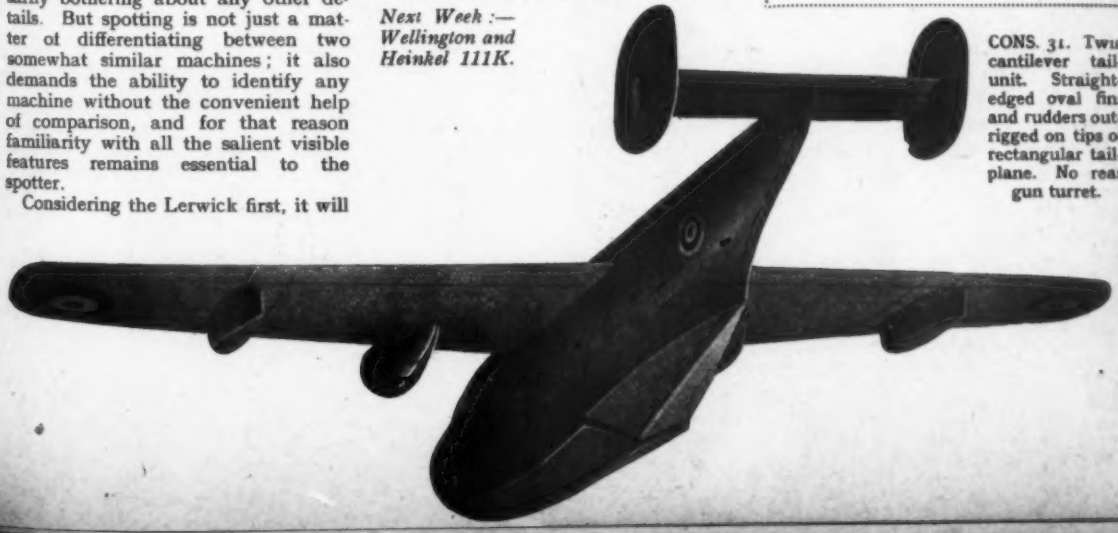
Next Week :— Wellington and Heinkel 111K.

SARO LERWICK



CONSOLIDATED 31



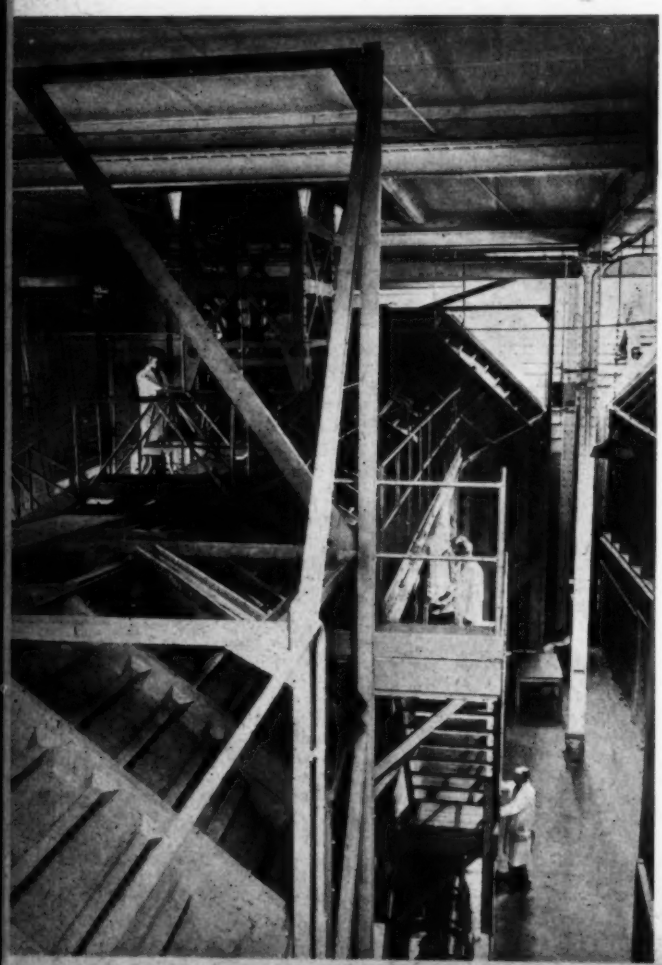


CONS. 31. Twin cantilever tail-unit. Straight-edged oval fins and rudders outrigged on tips of rectangular tailplane. No rear gun turret.

A PRIVATE RESEARCH LABORATORY

Model of a four-engined aircraft in the Fairey wind tunnel.

How the Fairey Aviation Company Keeps Up-to-date : A Wind Tunnel with Speeds up to 145 m.p.h. Mechanical, Metallurgical and Chemical Laboratories



ALTHOUGH a great deal of aerodynamical research has been and is being carried out in Government establishments in all the aircraft-manufacturing countries, the firm which has its own wind tunnel is obviously at a considerable advantage. This is always so, but more particularly during a war, when the Government establishments are working to capacity on urgent problems for the whole aircraft industry. In such circumstances a firm may well have to wait months before it is able to have tests made in one of these.

One result may be that it becomes expedient to build the prototype of a new aircraft which incorporates certain features about which the designer would have liked more information before committing himself to actual construction. If the firm has its own wind tunnel, the answers can be found before construction has gone too far, and if insurmountable snags are found, the design can be altered before any great expense has been incurred. Intelligently used, a wind tunnel can be made to pay a handsome dividend, in spite of the fact that it is of necessity an expensive piece of equipment.

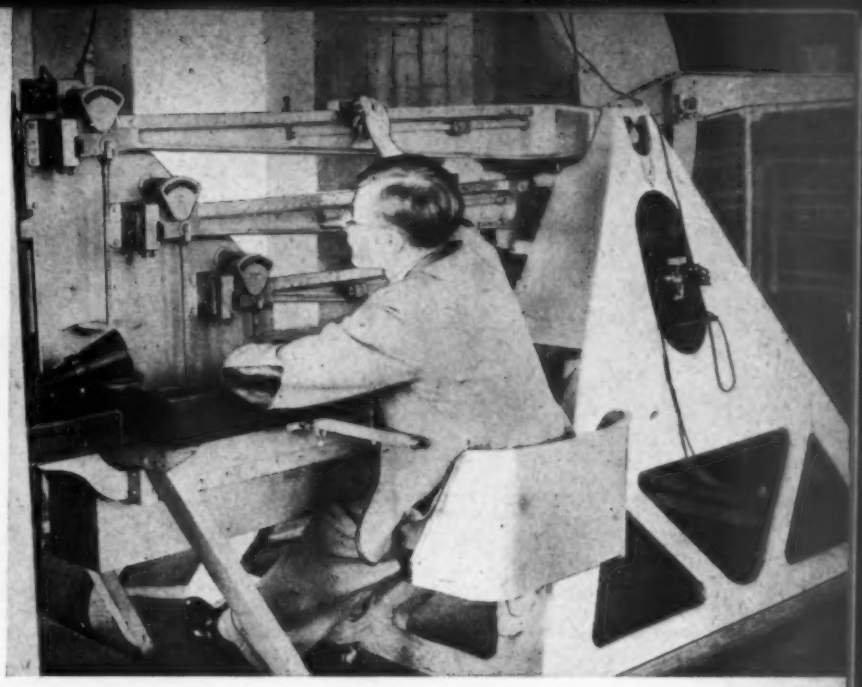
Finding Out

Some years before the outbreak of war, the Fairey Aviation Co., Ltd., made plans for very extensive development work, and this included the solution of many technical problems. Mr. C. R. Fairey has, from the very earliest days, been a firm believer in the need for and value of exhaustive testing of everything that goes into an aircraft, and he has never hesitated to set aside large sums for this kind of work, knowing full well that in the long run the money would prove to have been well spent.

Thus, when the board of directors discussed the programme for the future, it was decided that the best guarantee of success would be to start with a research department sufficiently well equipped to be capable of dealing with any problem likely to arise.

The item which figured in the forefront of such a depart-

External view of the tunnel. On top can be seen the supports for the balances. The steps on the right lead to the door of the working section.



One observer can operate the balances, as the three beams are placed one above the other.

ment was a wind tunnel, and in the usual Fairey manner the directors agreed that it should be large enough and have an air speed high enough to give a Reynolds Number which would reduce scale effect to values at which corrections could be applied from the data supplied by such Government tunnels as the compressed-air tunnel of the N.P.L.

After examining the problem in great detail, it was decided that a tunnel with an elliptical working section measuring 12ft. across and 10ft. in height (giving a cross-sectional area of about 94 sq. ft.), in which an air speed of 212ft./sec. could be attained, would meet the requirements. A new building had to be erected for housing the tunnel; this measured 121ft. 6in. in length, 50ft. in width, and 27ft. high. In this building was erected the wind tunnel itself, which was not only designed but actually built by the Fairey staff. • The tunnel is of the closed-circuit type, with closed working action or experimental chamber.

The Three-component Balance

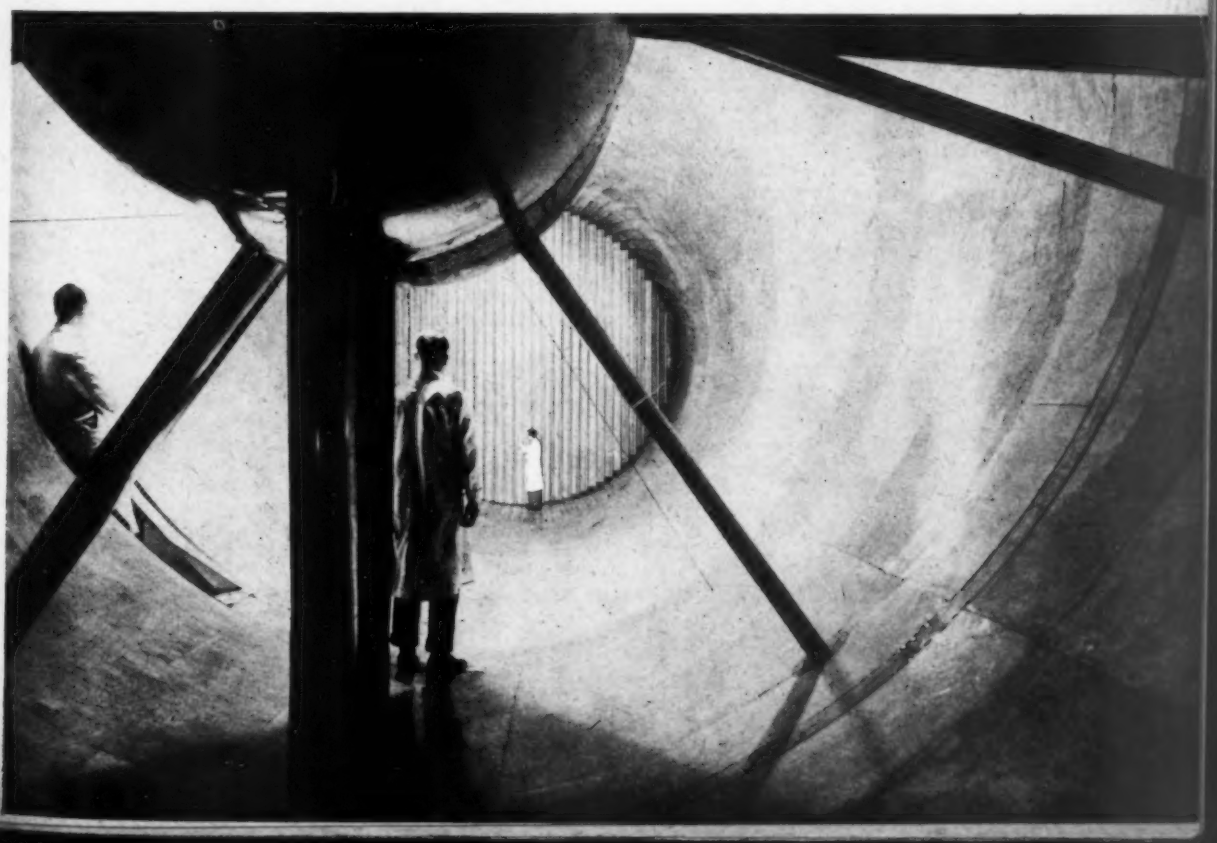
After due consideration it was decided that a three-component balance, capable of measuring lift, drag and pitching moments would best meet requirements as to the main balance. The other three components are measured on separate balances. The main balance was designed to measure lifts up to one ton, drags up to one-half ton, and the corresponding pitching moments. Its arrangement is a modification of a scheme due to Mr. W. S. Farren, who is now director of the Royal Aircraft Establishment.

The wind tunnel itself is 110ft. long, with four right-angle bends at which the air stream is turned by wing-section guide vanes. The working section is 22ft. long, and ahead of it is a contraction flare of 4 : 1 ratio. On the opposite side the main return trunk of the tunnel is a 7 deg. cone, 61ft. long, and with diameters of 22ft. and 14ft. respectively.

At the narrow end of the return trunk is installed the four-bladed fan, which is driven by an electric motor of 350 h.p. continuous rating. The fan bearings are mounted on radial supports, and these are covered with fairings of wing section and given a twist. In front of the fan are similar radial vanes, the two sets serving to straighten the air flow on its way to the working section of the tunnel. In the planning of many of the tunnel details the Fairey company received considerable help from the Aerodynamics Department of the National Physical Laboratory and from the Royal Aircraft Establishment.

The structural work was carried out entirely by the firm's artisans, and is of wood with steel frames in the region of the fan and at each end of the working section.

An electric motor of 350 h.p. drives a four-bladed fan of 14ft. diameter. Note the radial vanes which take the twist out of the airstream.



A PRIVATE RES

Spraying specimens with sea water to test anti-corrosion properties

A view

The return trunk and the panels of the working section are of five-ply wood, one-half inch thick. The contraction flare in front of the working section is of double-diagonal construction, the skins being five-ply, one-quarter of an inch thick. The whole structure was designed to have a minimum load factor of 8 under normal power output.

For driving the fan, electrical equipment is installed in a separate power room. Electricity is taken from the commercial mains at 6,600 volts. This pressure is reduced by a transformer to 420 volts, and used to operate a 410 h.p. electric motor which in turn drives two direct-current generators. One of these supplies current to the field coils, and the other to the armature windings of the main direct-current motor, which is of 350 h.p. and flexibly coupled to the shaft of the fan. This type of installation gives extremely accurate control of the motor, and consequently of the air speed. It might be mentioned here that the speed control equipment is installed in the balance room, above the working section of the tunnel.

Safety Measures

An interesting safety precaution is found in the plane of the fan. A metal strip runs around the circumference of the tunnel walls, which are but a small fraction of an inch away from the tips of the fan blades. Should the fan mounting get sufficiently out of line, a very unlikely occurrence, the blade tip would make contact with this strip, and in doing so would close an electrical circuit which would switch off the motor. A further precaution against damage takes the form of sprung wire-netting to catch any piece of the wind tunnel model that might by mischance break away.

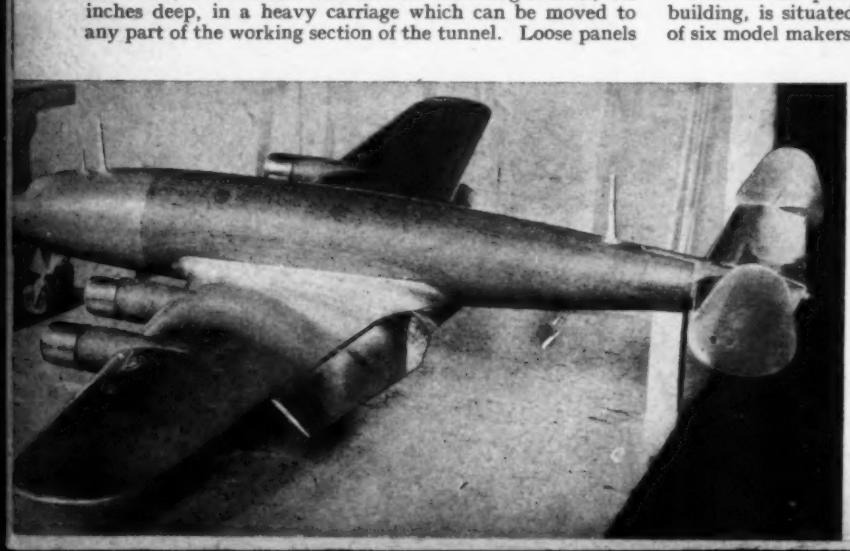
The three-component balance itself is of considerable interest. It was designed and built by the firm, and incorporates, in part, the scheme used in some of the balances of the R.A.E., and, in part, a method designed by Mr. W. S. Farren while he was at Cambridge University. Rigidity being a very important factor, the balance is mounted in a frame of aluminium alloy castings weighing approximately one ton. This frame, which can be yawed full circle, is mounted on a stiff turn-table ring of steel, ten inches deep, in a heavy carriage which can be moved to any part of the working section of the tunnel. Loose panels in the latter are so designed that the model suspension wires are accommodated while the rest of the tunnel roof is closed completely.

One observer operates the balance, the process being greatly facilitated by the arrangement of the three weigh beams above one another. The incidence of the model is varied from the observer's seat, and its value is read on a large graduated quadrant. Lift and drag forces can be read direct in pounds, while pitching moments can be derived as the actual air moment on the model after subtracting the moments due to the weight of the model.

All suspensions and links in the balance are in the form of steel springs, 0.025in. thick. No knife edges or pivot bearings are used for important balance parts. Similar spring suspensions on balances at the R.A.E. have proved a sensitivity of one part in sixty thousand of the balance range.

Next to the power room, at one end of the laboratory building, is situated the model workshop in which a staff of six model makers are employed. A band saw and boring machine are installed in the workshop to expedite the initial stages of model-making, but the final work, which requires very great accuracy, is hand-finished.

In addition to the very fine wind tunnel and its ancillary equipment, the Fairey research establishment includes large and very thoroughly equipped mechanical, metallurgical and chemical laboratories. All are housed in the main wind tunnel building, so that all research, of whatever character, is grouped very conveni-



A wind tunnel model of the Fairey F.C.1. Note the Youngman flaps.

LABORATORY

laboratory

ently, and forms, in fact, a self-contained unit within the larger plan of the works.

The aeronautical engineer relies for his design data very largely upon the mechanical testing of materials and new types of structure. Not until these have been supplied can he design his structure with the certainty that it will bear the loads which he intends to place upon it. The Fairey mechanical test laboratory is equipped not only to deal with the testing of experimental materials and structures, but also with the testing of specimens of normal materials before they are issued to the shops, and with the calibration and testing of instruments.

Fatigue testing of materials plays an important part in aircraft engineering, and in the Fairey mechanical test laboratory systematic investigations are always going on. Two batteries are available, each comprising three fatigue testing machines. The machines of one battery are of the R.A.E. type, while those of the other are of the N.P.L. type. The latter are used for finding the fatigue range in bending, torsion and a combination of the two. The machines run at 1,500 r.p.m., and a microscope is used for calibration.

An Amsler machine with a capacity of 25 tons is frequently used for the investigation of mechanical properties of metals at high temperatures. The machine, which is of the hydraulic loading type, is operated by a triple pump, and for tests at high temperatures the specimen under test is submerged in a bath of oil, heated by an electric immersion heater. The temperature is checked by a standard thermometer.

A Denison ten-ton universal testing machine is used for tension, compression and bending tests on all classes of materials, and for testing built-up structures, long struts and cables. That machines are available for the determination of Brinell and Vickers hardness numbers, and for Izod impact values of metals, timbers and synthetic materials, goes without saying. They are so universally employed, and consequently so well known, that a detailed reference would be superfluous.

The Vickers projection microscope used in the Fairey laboratory will give magnifications up to 2,000 diameters.

Some of the equipment in the mechanical test laboratory. In the foreground is a battery of fatigue-testing machines.

Of greater general interest is the rig used for testing the dynamic balance of supercharger impellers, high-speed gears, and so forth. In this rig the components to be tested are checked and adjusted for dynamic balance after being statically balanced on knife edges. The part on test, supported in ball bearings in a balanced frame, is spun at high speed by means of air jets. The air pressure is cut off and the part allowed to run freely. The amount, if any, by which it is out of balance is indicated by a series of levers and by a beam of light focused on a scale at each side.

Instrument-testing

Not the least interesting side of the mechanical test laboratory is the instrument section, which deals with the calibration of aircraft instruments. Airspeed indicators are calibrated on two instruments, one a water manometer and the other a mercury manometer. Over the lower ranges of air speeds the calibration is effected, in the water type, by the displacement of a water column. A float indicates the water level and transmits this indication to a dial by means of a chain with a balance weight. For higher speeds, up to 500 m.p.h., vertical water or mercury column manometers are used.

Altitude indicators are calibrated in a vacuum chamber from which the air is exhausted by a hand pump. The chamber enables calibrations up to the equivalent of 30,000ft. to be made. Boost gauges and pressure gauges are also calibrated by vacuum and positive pressure pumps.

Synthetic materials are gradually coming into use in aircraft, and it is therefore important to have reliable

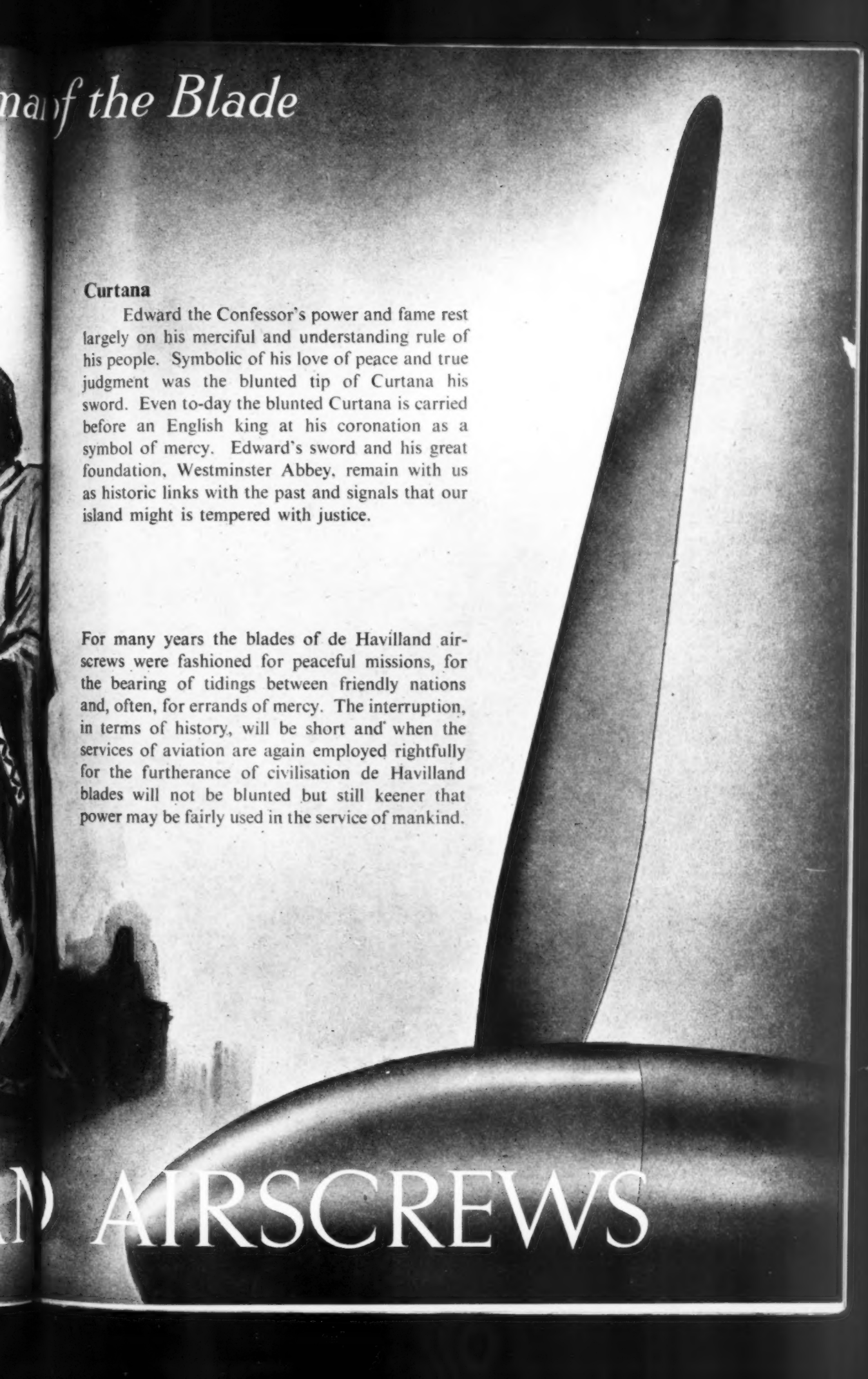
FLIGHT, NOV. 13TH, 1941.
Advts. iii. & iv.

...n of the Blade

Curtana

Edward the Confessor's power and fame rest largely on his merciful and understanding rule of his people. Symbolic of his love of peace and true judgment was the blunted tip of Curtana his sword. Even to-day the blunted Curtana is carried before an English king at his coronation as a symbol of mercy. Edward's sword and his great foundation, Westminster Abbey, remain with us as historic links with the past and signals that our island might is tempered with justice.

For many years the blades of de Havilland airscrews were fashioned for peaceful missions, for the bearing of tidings between friendly nations and, often, for errands of mercy. The interruption, in terms of history, will be short and when the services of aviation are again employed rightfully for the furtherance of civilisation de Havilland blades will not be blunted but still keener that power may be fairly used in the service of mankind.



...N AIRSCREWS

A PRIVATE RESEARCH LABORATORY

data of the degree to which they absorb moisture. A water oven is available for investigations of this nature; this can, of course, be used for similar work on timbers. A chemical balance is used for checking the weight of specimens before and after treatment.

Progress in aircraft engineering is closely linked with the introduction of new materials, and thus the examination of the internal structure of materials forms an important branch of research. The Fairey metallurgical and chemical laboratories are well equipped for undertaking a wide range of researches in addition to routine control of works processes. Mention may be made, by way of examples, of metallurgical control of steels and light alloys; research into new plating and protective schemes for metals; investigations of defects, new materials, new processes and works problems.

Space is not available for a detailed discussion of all this equipment, but in connection with the examination of the internal structure of metals it may be mentioned that a special micro room contains a Vickers projection microscope, which is capable of magnifications up 2,000 times.

Corrosion Tests

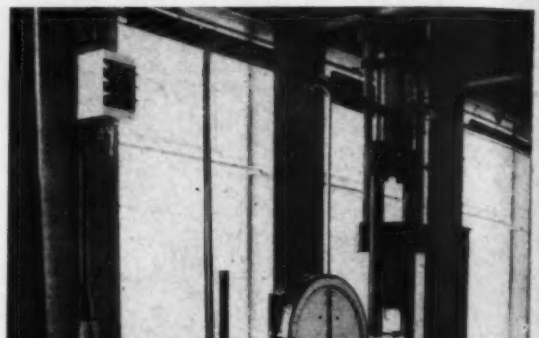
It is probably correct to say that the Fairey Aviation Co., Ltd., was one of the first British firms to undertake systematic research into the problem of corrosion and its prevention. The fact that the firm has always been intimately concerned in the production of seaplanes and of landplanes for the Fleet Air Arm has made such research imperative. In modern times the firm's laboratories have put this class of research on a more scientific basis than was possible in the early days of flying, and gradually a fund of knowledge is being accumulated which is applied to the full in the design of every new type of Fairey aircraft, and in the adoption of new materials.

Anodic treatment has proved one of the most successful anti-corrosion processes, and an experimental anodising plant in the chemical laboratory is used for investigating improvements in anodic treatment of aluminium alloys. In this connection reference may also be made to the apparatus used for measuring the di-electric strength of the anodic film. An electrometer is used for measuring the galvanic action between metals in contact, the figure obtained giving an indication of the susceptibility to accelerated corrosion.

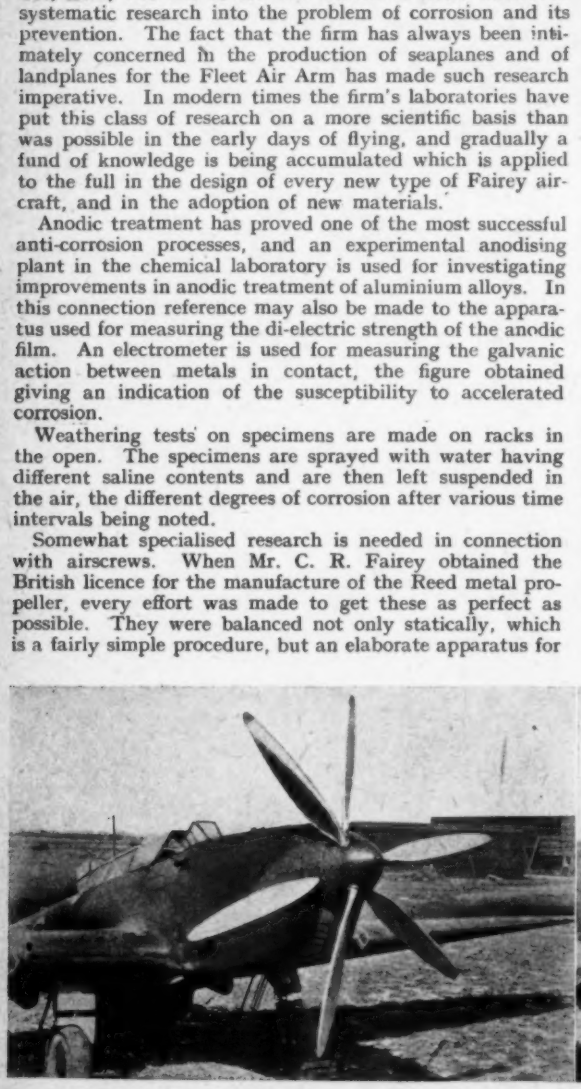
Weathering tests on specimens are made on racks in the open. The specimens are sprayed with water having different saline contents and are then left suspended in the air, the different degrees of corrosion after various time intervals being noted.

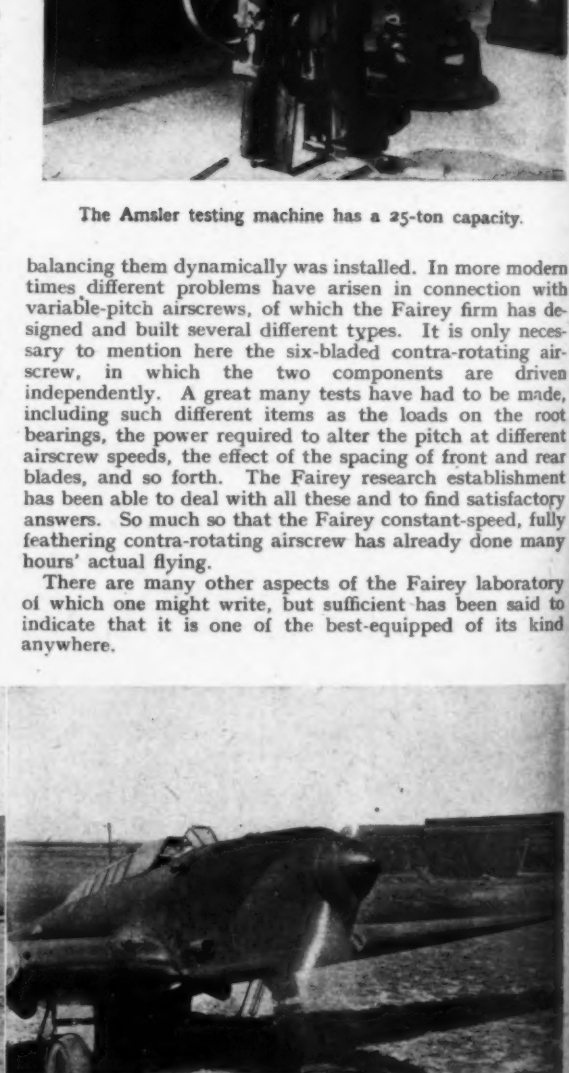
Somewhat specialised research is needed in connection with airscrews. When Mr. C. R. Fairey obtained the British licence for the manufacture of the Reed metal propeller, every effort was made to get these as perfect as possible. They were balanced not only statically, which is a fairly simple procedure, but an elaborate apparatus for balancing them dynamically was installed. In more modern times different problems have arisen in connection with variable-pitch airscrews, of which the Fairey firm has designed and built several different types. It is only necessary to mention here the six-bladed contra-rotating airscrew, in which the two components are driven independently. A great many tests have had to be made, including such different items as the loads on the root bearings, the power required to alter the pitch at different airscrew speeds, the effect of the spacing of front and rear blades, and so forth. The Fairey research establishment has been able to deal with all these and to find satisfactory answers. So much so that the Fairey constant-speed, fully feathering contra-rotating airscrew has already done many hours' actual flying.

There are many other aspects of the Fairey laboratory of which one might write, but sufficient has been said to indicate that it is one of the best-equipped of its kind anywhere.



The Amsler testing machine has a 25-ton capacity.





1,500 h.p. FORD V-12

Further Details of New Project : Turbo-blower and Direct Injection

By HARRY WILKIN PERRY

THE following notes from an American correspondent add a few details which were not known at the time we published our previous references to the new Ford aircraft engine (August 21st and September 11th).

With direct fuel injection and turbo-supercharger the new engine will be really up to date. Apparently the Ford concern is not entirely convinced of the superiority of the sleeve valve, at least not sufficiently so to incorporate it.

CONCURRENTLY with the building of a huge new plant for the manufacture of 1,650 Pratt and Whitney double-row Wasp air-cooled radial engines for the United States and British air forces, the Ford Motor Company has been developing a liquid-cooled engine of its own, financing the development with its own funds to be wholly free to incorporate the ideas of the company engineers in an original design.

The decision to undertake this programme was made a year ago last June. Designing started the following month, and early this year a model was completed. The new engine is a V-12 supercharged, having a volumetric displacement of 1,650 cu. in.

Test runs have been conducted for several months on a two-cylinder test engine consisting of a pair of the new cylinders and camshaft and accessory drives identical with those for the complete engine. This test engine withstood speeds up to 3,600 r.p.m., developed the power set as the goal, and indicated that the twelve-cylinder engine would have a cruising speed of 3,000 to 3,200 r.p.m.

Ideas underlying the development and some of the unusual features incorporated in the design were discussed by C. W. Van Ranst, of the Ford Company, in a paper presented at a meeting of the American Society of Tool Engineers, from which the following information is derived.

It was decided at the start that the engine should be highly supercharged by an exhaust turbine-driven supercharger, and that fuel should be injected directly into the combustion chamber as a liquid. In laying out the design, the objective was to provide a complete unit power plant in which the supercharger, exhaust turbine and an air intercooler are integral parts of the engine, and to evolve a design that would minimise expensive machining operations and simplify accessibility of parts for maintenance and repair.

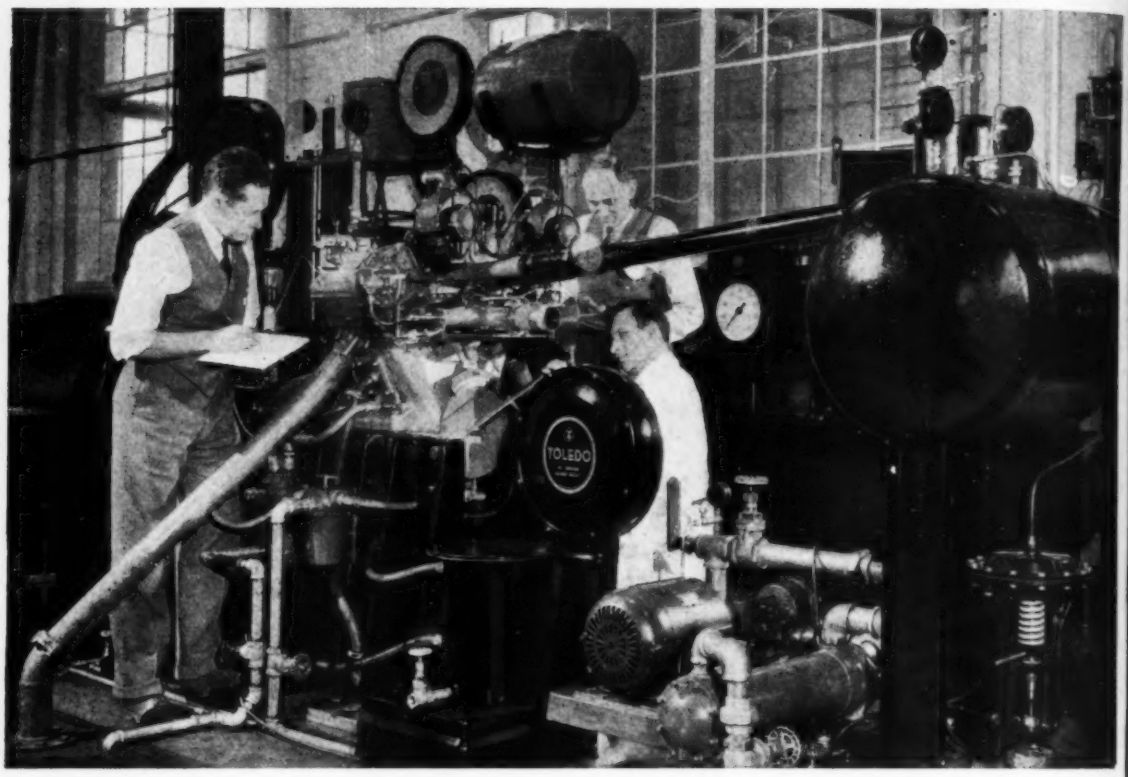
High aerodynamic property was achieved by directing the supercharger air intake and the exhaust from the turbine in the line of flight, thereby avoiding drag from the intake and obtaining appreciable propulsive effect from the exhaust. The model has the supercharger built on the rear end, with the air scoop directed forward along the lower side of the engine. The turbine is on the back of the compressor and encircled by an exhaust ring, into which spent gases from the cylinders are fed from a straight pipe on the side of the crankcase. An air intercooler at the top of the V between the cylinder banks reduces the compressed air temperature before the air is admitted to the inlet valves. The whole engine assembly is neatly streamlined and proportioned to fit into the pointed nose of a plane.

Choice of the exhaust-driven supercharger was made because it avoids the complication of a two-stage compressor, which would be required to produce and maintain the higher manifold pressure needed at great altitude, and is claimed to give nearly 15 per cent. more power-increase than the mechanically driven supercharger. This increase amounts to a gain of 250 h.p. on a mechanically supercharged engine delivering 1,800 h.p.

Injecting fuel directly into the combustion chambers and increasing the usual overlap of open exhaust and inlet valves enables use to be made of air alone from the compressor for better scavenging of the cylinders and more cooling of valves and piston heads. As scavenging occurs at top piston position, just before fuel injection, the only loss is a small quantity of air. Relative location of injector nozzles and spark plugs is very important to maximum efficiency, and requires special engine design.

Experience of the engineers indicates that, by adding a supercharger weighing approximately 75 lb. and strengthening the engine by use of about 100 lb. more metal to withstand the higher combustion pressures and the higher speed, an engine

NOT A "TIN LIZZIE": With Mr. Henry Ford at the back of the group is General Arnold, U.S.A. Deputy Chief of Staff. They are discussing the wooden mock-up of the new Ford aircraft engine.



EARLY STAGES: Ford mechanics attending the two-cylinder test model from which data are obtained for the complete engine. Speeds up to 3,600 r.p.m. are said to have been reached.

can be built of the same volumetric capacity to develop 1,900 h.p. at sea level as compared with 950 h.p. of an atmospheric-pressure engine, and that such an engine will weigh less than 1 lb./h.p.

The company set up a research department and undertook to design its own compressors and turbines because these are such intimate parts of the new engine, and their best functioning is so essential to its successful performance. Considerable departure from the conventional turbine supercharger has been made, with the object of obtaining greater efficiency than heretofore.

Special attention was given to designing the engine for unusual rigidity, in the belief that insufficient stiffness accounts for failure of current engines to operate at higher speeds. The design provides for a cast-steel counterbalanced crankshaft having a liberal overlap of crankpins and main bearings and large crank cheeks. Cylinders are cast integral with the aluminium crankcase, and are water-jacketed the full length of the barrels. They have dry-type steel liners, centrifugally cast and oil hardened, which add considerable stiffness to the structure. Flanges and bosses are omitted from the cylinders to avoid unequal expansion by heat and consequent piston-ring flutter set up by irregularity of cylinder walls, which results in excessive blow-by at high combustion temperature and pressure.

Piston-ring seal and longevity are further favourably affected by design of the pistons, which have a length nearly equal to the diameter, and therefore will not rock in the cylinders. The large area of the piston wall also aids in dissipation of heat from the piston head.

Connecting rods are of the same type as those in the Ford V-8 automobile engine, and have floating bearings. Rods for cylinders on the two sides of the V are of identical design and size, and are disposed in pairs side by side on the same crankpin, thus facilitating dynamic balancing and saving weight. This also makes for reduction in manufacturing cost.

Britain's Improved Air Defences

THE effectiveness of Britain's balloon barrage was disclosed by a senior R.A.F. officer at a recent Press conference at the Air Ministry, when he revealed that German machines had been captured which were fitted with a fender device as a measure of protection against balloon cables. This fender, which weighs as much as 800 lb., not only has the effect of restricting the bomb-load by a comparative amount but also reduces the raider's speed by some 25 m.p.h. and renders it unable to keep aloft if one of its two engines is put out of action.

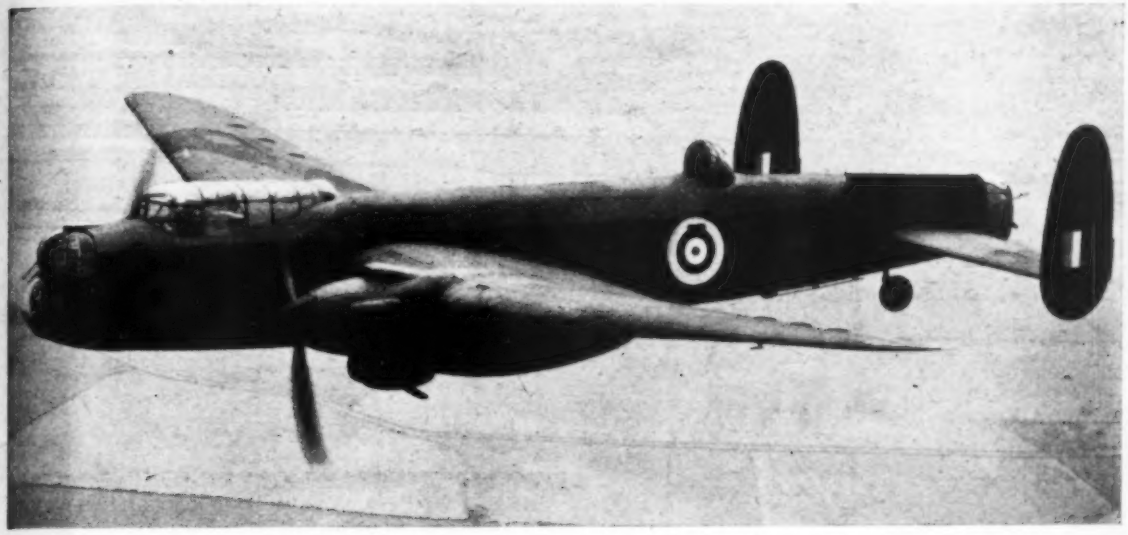
"The more armament and protective devices we can force the Hun to pile on to his aircraft," said the officer, "the less weight of bombs he can bring over here—and we have by no means reached the limit of our development in barrage balloons."

A.A. defences also continue to show tremendous improvement, and the Germans were exercising far more caution in their visits and giving more attention to shipping and ports than to inland targets.

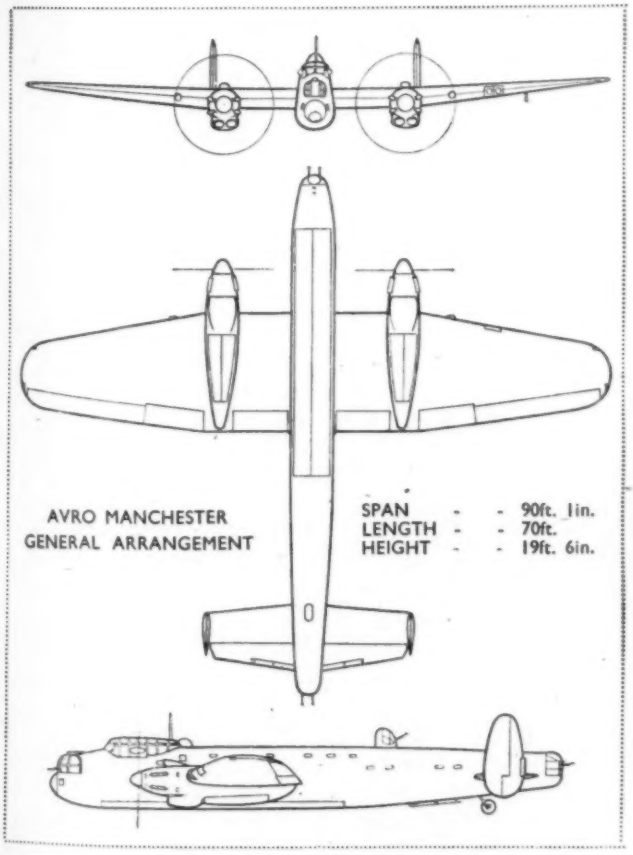
German defences had also shown signs of improvement, but our own night defences were still well ahead of theirs. Bad weather had prevented R.A.F. bombing operations on 15 days and 12 nights in October, yet, despite this, we had dropped nearly twice the weight of bombs dropped in October, 1940, when the weather was far better. During August, September and October this year we had dropped more than 10,000 tons of bombs on Germany and enemy-occupied territory.

AVRO MANCHESTER

First Photographs of One of Britain's New Heavy-weights : Rolls-Royce Vulture Engine Taking Part in Operations



With undercarriage retracted, the Avro Manchester has particularly clean lines. This view shows clearly the fields of fire of the three gun turrets. Earlier models of the Manchester have a third fin on the fuselage



THE Avro Manchester is outstanding in that it is the only one of our new heavy bombers to be fitted with two engines. All the others, with the exception of the Stirling, have four engines of approximately half the horse-power each. Liquid-cooled, 24-cylinder Rolls-Royce Vulture engines are fitted and, while no official pronouncement has been made, the power output is said to be in the region of 2,000 h.p.

Structurally the Manchester is an all-metal, mid-wing monoplane with a fuselage which is roughly oval in section. For ease in construction and transportation the fuselage is divided into five distinct sections.

As will be seen from the general arrangement drawing, the centre section of the cantilever wing is rectangular in plan form. Outboard from the

A three-quarter front view from underneath of the Manchester, which will be of value to spotters.

engines it tapers both in plan and elevation to the rounded wing tips. The tailplane also tapers in both plan and elevation and the fins and rudders take the form of end plates. All surfaces are sheet metal covered, with the exception of some of the movable control surfaces.

It is surprising to find that the Manchester has only 9ft. less span than the Short Stirling. In height there is only 3ft. 3in. difference between the two types, but from nose to tail it is 17ft. shorter than the Stirling.

In accordance with modern practice a cabin heating system is installed and de-icing equipment is provided for the tail unit, wireless mast and airscrews.

Of interest is the sloping optical-flat glass panel to give the bomb-aimer undistorted vision of his target. Whitley, Hampden, Blenheim, Beaufort and Halifax all have sloping panels, whereas the Wellington and Stirling have theirs in the horizontal plane. It would be expected that the sloping panels would be the cause of a lot of unpleasant reflections when in the neighbourhood of searchlight beams.

(*Top*) In this view is shown the neat installation of the Rolls-Royce Vulture engines. All the turrets are power-operated with two machine guns in the nose, another pair in the dorsal position, and a further four in the rear stinger turret.

(*Centre*) For its size the Manchester has very smooth body lines, but the oval section has not been attained by sacrificing bomb carrying space.

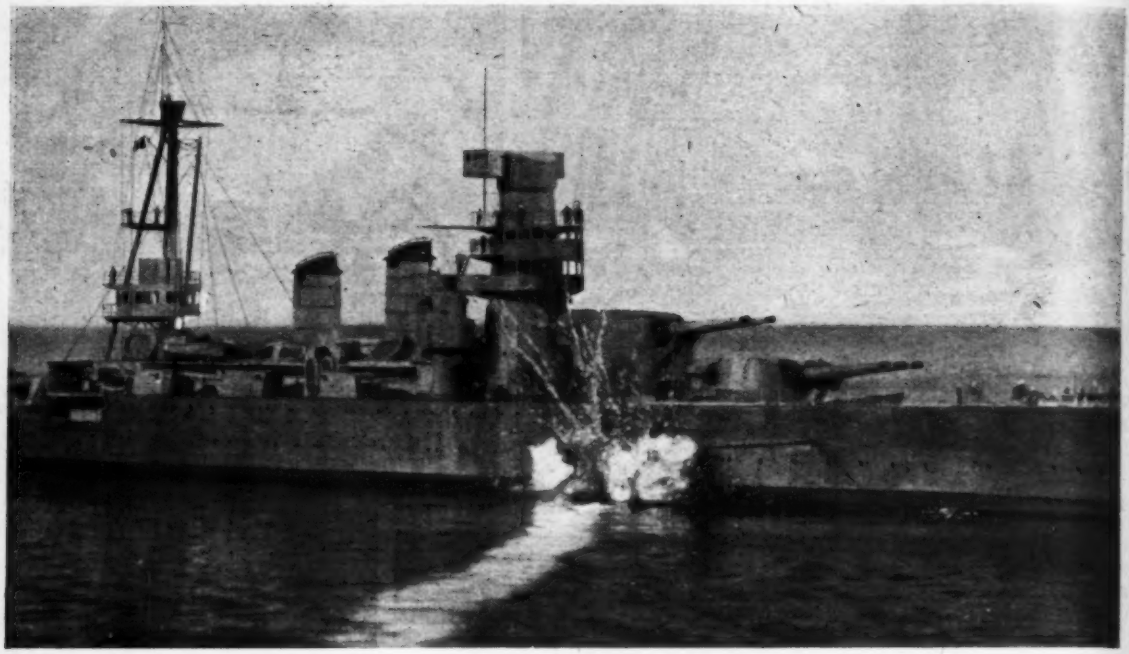
(*Bottom*) As a twin-engined bomber the Manchester appears much smaller than it actually is. In this view the figures in the foreground make it easier to appreciate the actual size.

(*Top, left*) A view looking aft down the fuselage tunnel, showing a member of the air crew at the flare chute.

(*Top, right*) Looking forward in the nose, the first and second pilots sit side by side with the navigator at the back of the first pilot. The bomb-aimer's position can be seen in the bottom right of the picture.

(*Left*) Immediately aft of the navigator, on the other side of a half partition, sits the wireless operator.

The mid-wing arrangement necessitates a fairly tall undercarriage, but airscrew ground clearance for engines of the Vulture's horse power would require this in any case.



THE "MOULDY" FINDS ITS MARK: A Fairey Swordfish torpedoes an Italian battleship. Note the track of the torpedo.

"SHIPS WITH WINGS"

Realism and Good Flying in New Film: Fleet Air Arm in the Mediterranean

AFTER a somewhat sloppy start the new film which began its run at the Gaumont, Haymarket, London, last Sunday, warms up to a really impressive sequence of shots. The inevitable love affairs are woven into the plot, but they do not obtrude unduly, and on the whole the picture is a man's film. It deals with the work of the Fleet Air Arm in the Mediterranean, and the flying is of a very high standard. The British types of aircraft involved are Fairey Swordfish and Fulmar.

Although not following closely the actual Mediterranean events which thrilled the world some time ago, one has no difficulty in identifying several of them in the film. The small Greek island, the Italian base of "Panteria," the aircraft carrier "Invincible," all have their counterparts in reality.

The fact that the interior shots show side-by-side seating in a Fulmar is a slightly irritating "brick," but is of small importance in an otherwise excellent film.

OFF TO "PANTERIA": A Fulmar takes off from the damaged deck of a carrier. The picture in the centre shows two Breda 88s being bombed.

THROUGH GERMAN EYES

Details of Armour Protection and Armament on British Aircraft Brought Down in Enemy Territory

THIS article, "The Armament of Enemy Aircraft as Ascertained from Captured Machines," by Fl. Staff Engineer J. Beseler, of Berlin, is translated from the August, 1941, issue of the German journal **Luftwissen**. *It contains a certain amount of hitherto unpublished information regarding the thickness and amount of armour plate used, but some of the armament details are wide of the mark. Obviously, it is not to the country's advantage for us to point out the errors one by one, but most of our readers will recognise them.*

THIS report deals separately with the following points: Armament and armour plate protection of the fighters; Vickers Supermarine Spitfire and Hawker Hurricane; and of the bombers: Fairey Battle, Bristol Blenheim, Handley Page Hampden, Vickers Wellington, and the Armstrong-Whitworth Whitley V.

The weapons, viz., the Browning and Vickers machine guns, of the 7.7 mm. calibre in both cases, have not been modified in any way, so that there will be no need to deal with this point. As regards ammunition, only one new type of projectile has made its appearance. This is a simple, small explosive incendiary bullet (of the 7.7 mm. calibre), designed as a sort of substitute for the explosive shell of the 20 mm. cannon still lacking in the British Air Force.

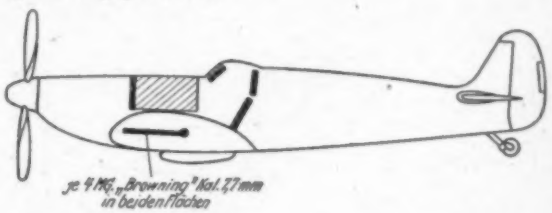
As armour protection for the crews and partly also for the fuel and lubricating oil tanks, use is made of steel plates having a thickness of 4 to 8 mm., the positions of which can be seen from the individual outline sketches of the various machines. The value of this protection, which is provided chiefly against attack from the rear, is not very great against direct hits from the usual aircraft and A.A. weapons, while the weight expenditure, amounting roughly to 50 kg. in the case of fighters, and 70 kg. in the case of the bombers, and even over 200 kg. in one particular case, is very high as compared with its usefulness.

Originally the fuel tanks were unprotected. But after a time an adaptation was made to conditions at the front, first by covering the tanks with armour plate, and later by the use of tanks the metal body of which was covered with a 5 to 15 mm. thick layer of rubber, sponge rubber and fabric. Although the combination affords but limited protection against hits, the risk of fire being caused as a result of leaks on a crash landing is thereby greatly diminished.

A British fuel tank showing the various layers of protective material.

Supermarine Spitfire

The preference of the British Royal Air Force for armament consisting of a great number of small calibre weapons both on their fighters and their bombers was already well known in pre-war times, and has been confirmed on all the fighters engaged so far.



Supermarine Spitfire fighter : 1,050 h.p. engine, 550 km/hr. The eight machine guns are distributed over the whole span. Thick lines indicate position of armour plate.

The eight fixed machine guns of the Spitfire are installed in the wings, on a comparatively large base. The outer gun is placed at a small distance only from the wing-tip (about 1.2 metres with a span of 11.2 metres). The mounting of the machine guns in the wings is carried out in a simple manner. The ammunition is fed from disintegrating link belts containing about 500 rounds, stowed in readily interchangeable boxes close to the guns. To prevent stoppages due to the cold, all the eight guns can be heated by means of hot air. The air is taken from behind the radiator and carried through pipes of pressed material having an internal diameter of about 60 mm. Operation, firing and loading are all under fully automatic control from the joystick. The sighting apparatus used is a reflector sight of the usual construction.

The outstanding feature of the protection provided for the pilot's cockpit is the heavy armoured glass panel fitted in front of the pilot's head. It consists of several sheets of glass with intermediate layers of celluloid, and it affords good protection against projectiles fired from a great distance. Apart from this panel the pilot is protected in front by the engine itself and also by armour plate arranged behind, in the upper part of the fuselage. In addition, a 3 mm. thickness of light metal plate is provided over the fuel tank, so that the latter may be protected from damage by bullets. Behind the pilot's seat, level with his head and back, are two "man-wide" plates 8 and 6 mm. thick.

Hawker Hurricane

The Hurricane carries the same armament as the Spitfire, with this difference, that the machine guns are not here spaced out as far as the vicinity of the wing-tips, being grouped as a unit on each wing.

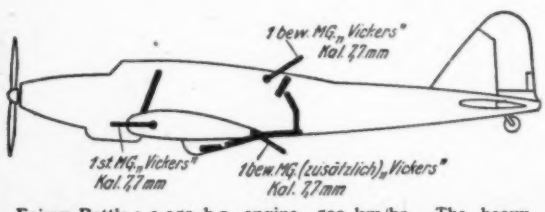
THROUGH GERMAN EYES

As regards protection, this also is similar to that provided on the Spitfire. But the fabric covering on the fuselage increases vulnerability to bullet hits and the fire danger.

Hawker Hurricane : 1,050 h.p. engine, 530 km/hr.

Fairey Battle

The already obsolescent Battle appeared in large numbers in the campaign in France. It is mentioned in this report only because of its heavy armouring. The side elevation shows the positions of the individual plates, about 4 mm. thick, which were designed to afford protection against bullet hits from the front, the rear, and also from below—chiefly with a view to employment in ground fighting. Of interest in this connection is the semi-fixed gun installed

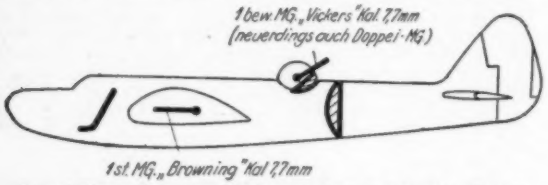


Fairey Battle : 1,050 h.p. engine, 500 km/hr. The heavy armour protection underneath is for protection in ground fighting.

under the fuselage to fire rearwards. It is mounted so "deep" under the fuselage that direct sighting is no longer possible. Sighting is accordingly effected with a mirror in conjunction with a sighting notch and bead. No information is available as to the results thus obtained. Besides this weapon the Battle also carried a fixed machine gun in the wing, and a free machine gun in the rear cockpit with a field of fire upwards and laterally.

Bristol Blenheim

The Bristol Blenheim mentioned in the previous report as being provided with comparatively weak armament was originally designed as a bomber, but is now in addition to be used as an "auxiliary destroyer." For this duty it has been fitted with four additional fixed guns installed under the fuselage and designed, in keeping with the offensive character of a "destroyer," to fire in the forward direction. Among the Blenheim aircraft shot down over occupied territory was a machine fitted with a fixed gun firing towards the rear. It was no doubt a case where the need for protection from attack in the rear had prompted inventiveness, and suggested that the Blenheim,



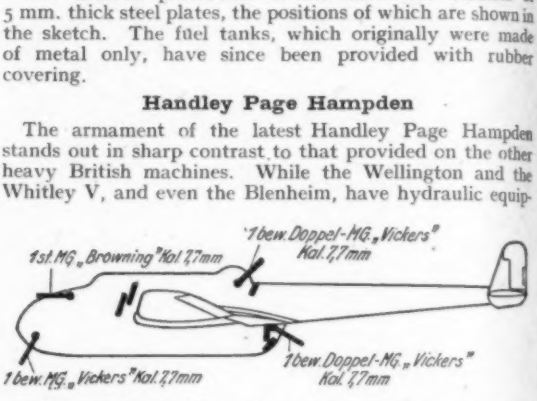
Bristol Blenheim : Two 860 h.p. engines, 470 km/hr. Recent models have twin Vickers machine guns in rear turret.

entirely unarmed aft underneath, should be given better protection by the provision, as an emergency measure, of an additional weapon. This gun is placed behind the engine in the engine nacelle, above the wing. In this case also sighting is probably effected—if at all—by means of a mirror along a sighting line arranged on the fuselage.

The armour protection of the Blenheim consists of 5 mm. thick steel plates, the positions of which are shown in the sketch. The fuel tanks, which originally were made of metal only, have since been provided with rubber covering.

Handley Page Hampden

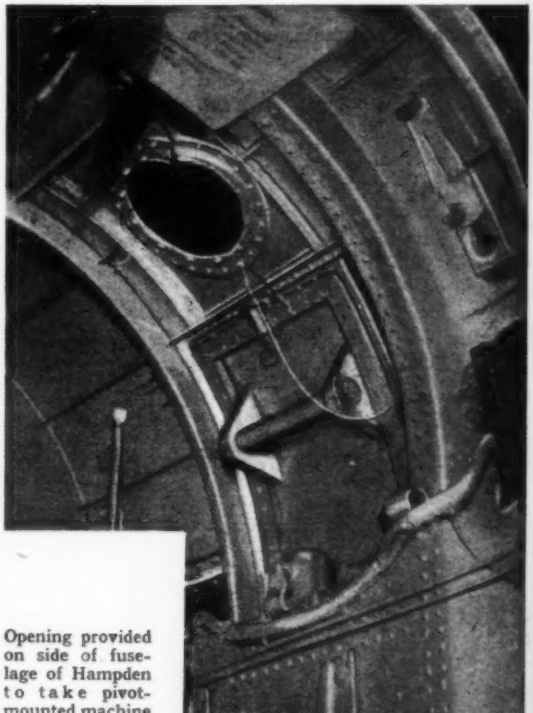
The armament of the latest Handley Page Hampden stands out in sharp contrast to that provided on the other heavy British machines. While the Wellington and the Whitley V, and even the Blenheim, have hydraulic equip-



Handley Page Hampden : Two 950 h.p. engines, 420 km/hr. Top and bottom rear turrets mount twin machine guns.

ment for operating the free machine guns, the Hampden is provided with hand-operated machine guns. Two gunners' positions, one above and one below, are each provided with twin guns, which undertake defence against attack from above, under, behind and the sides. The field of fire covered by these guns, which can be displaced transversally on a simple mounting, is as follows:—

Top: Elevation +50°, Traverse 2 × 30°.
Bottom: Depression −60°, Traverse 2 × 20°.



Opening provided on side of fuselage of Hampden to take pivot-mounted machine gun.

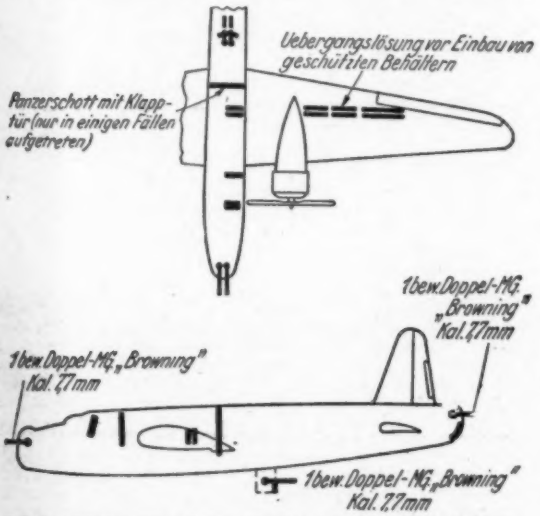
In a forward direction, the armament consists of a free machine gun in the gunner's cockpit, mounted on a simple fork support, and a fixed gun installed in front of the pilot. The latter weapon is fed from belts, while all the others are fed from drums.

It would seem as though the experience gained as to the efficaciousness of this armament was not satisfactory. In several cases it has been ascertained that in the side walls of the fuselage, about the wireless operator's seat, openings had subsequently been made for the use of additional defensive weapons. The photograph shows such an opening, with the bushing for supporting the gun. On the outside were also to be found bow-shaped steel guides provided as gun deflectors to protect the structure from the aircraft's own fire. The guns used are of the 7.7. mm. Vickers type. The sighting apparatus consists of sighting notch and bead.

Armour protection is likewise quite heavy in this machine, as may be seen from the sketch. The fuel tanks are protected in the usual manner with covering.

Vickers Wellington

The armament of the Wellington in the hydraulically operated turrets mounted in the nose and the stern, as also in a number of other aircraft, has not undergone any


Uebergangslösung vor Einbau von geschützten Behältern
Panzerschott mit Klapptür (nur in einigen Fällen aufgetreten)
1 bew. Doppel-MG. „Browning" Kal. 7,7 mm
1 bew. Doppel-MG „Browning" Kal. 7,7 mm
1 bew. Doppel-MG „Browning" Kal. 7,7 mm

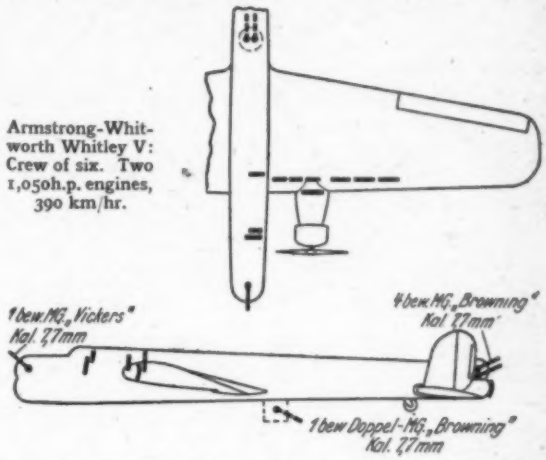
Vickers Wellington : Crew of six. Two 930 h.p. engines, 425 km/hr. Armour plates behind fuel tanks are a temporary measure prior to fitting protected tanks.

change since the previous report (March, 1940). On the other hand, the armour has now become heavier. The crew are afforded improved cover by the provision of the steel plates shown in the sketch. Quite special attention has been given to the fuel tanks in the wings. After the serious failures experienced over the North Sea, counter measures were immediately adopted. As not enough tanks with the new protective covering were yet available, the tanks installed in the wings were protected over their entire length by armour plate 4 mm. thick, against hits from the rear. As a further development, double plates were later provided until the present stage was reached by the installation of covered tanks.

Armstrong-Whitworth Whitley V

The best example of the increase in defensive armour is afforded by the Whitley. The Whitley I version, apart from a retractable turret provided with twin machine guns (Browning) and hydraulic operation, was armed in front and at the rear with only one light hand-operated Vickers machine gun, of the drum-fed type. The retractable turret offered but little room for the gunner and a poor field of fire, and when in the lowered position it meant a further reduction of the already low speed of the aircraft.

As the latest development, however, there emerged the Whitley V, which is equipped with more powerful engines, has great speed, and whose rear gunner's turret at the rear is now fitted with four 7.7 mm. Browning machine guns.



Armstrong-Whitworth Whitley V: Crew of six. Two 1,050h.p. engines, 390 km/hr.

As in the Wellington, operation is effected hydraulically by the gunner sitting in the turret. By this arrangement a high density of fire is attained. Hitting results, however, depend very much on the aircraft being kept stable, in view of the considerable distance separating the turret from the centre of gravity. Gusty weather or evading manœuvres place a heavy physical strain on the gunner as the result of accelerations, and considerably reduce the efficiency of the defensive fire.

In the nose turret is arranged a single Vickers machine gun. Operation of the turret and the gun is effected hydraulically by means of a control handle.

The armour protection of the aircraft is to be seen from the sketch. It should be observed, in this connection, that all the fuel tanks in the wings are protected at the back with armour plates.

External view of Whitley 4-gun rear turret : Full elevation + 70 degrees in about 3 seconds. Depression 40 degrees. Traverse 180 degrees in about 5 seconds. Ammunition boxes carry about 800 rounds.

Correspondence

The Editor does not hold himself responsible for the views expressed by correspondents. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters

"ACK EMMAS" OF THE LAST WAR

Over-forty Section for A.T.C. Suggested

HERE is a subject that I am sure will be of interest to most if not all of the men who served with the R.F.C. or R.A.F. in the last war.

Why not have a section of the A.T.C. for the "over-forties," something on the same lines as the Home Guard?

Given a few courses on the modern aircraft with its hydraulics, superchargers, V.P. airscrews, etc., the fitters, riggers and all the other trades who kept such 'planes as the BE2, RE8, Camel, DH9 and SE5 in the air could be a valuable practical asset.

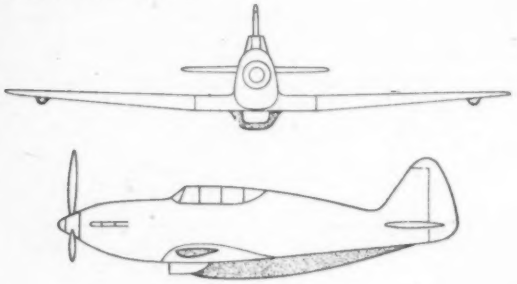
So what about an "old boys'" section of the A.T.C.?

F. J. M. (Fitter-engine 2 ARD, late R.F.C., R.A.F.).

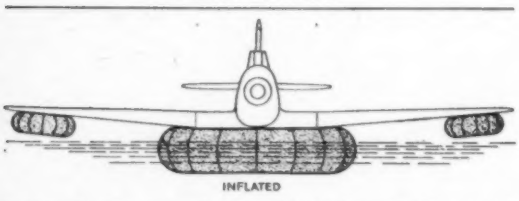
SEAPLANE FIGHTERS

Floating Gear to Save Aircraft

ON reading the article on seaplane fighters in your issue of October 16th, it occurred to me that it would be possible to fit self-inflating floats to the bottom of fighters used on convoy work so that the planes, as well as the pilots, could be rescued from the sea.



STOWED WHEN IN FLIGHT



INFLATED

If these floats were packed in a small streamlined case under the fuselage and perhaps a small one under each wing, they should not have any appreciable drag on the aircraft in flight and could be inflated on touching water in the same way as the dinghies used by our pilots I enclose a drawing of the idea.

F. WOODBRIDGE.

VALUE OF BOMBING

Sub-stratosphere Accuracy

MIGHT I be permitted to ask a question or two which may be of topical interest in the aviation field?

I notice that in an American non-technical paper circulated in this country there is a coloured photo of the new Packard plant producing Rolls-Royce engines. The machinery alone is stated to have cost 18,000,000 dollars, but what interested me was the statement that "In less than a year after the contract was signed, Packard had redesigned the famous engine used in Hurricanes and Spitfires and built the vast plant and started mass production." Did Packard redesign the engine or is this a misstatement?

The writer holds the view that night bombing should never have been started. Its high degree of inaccuracy in face of modern defences is beginning to be apparent in the almost negligible effect it has had on the German war machine which continues to operate slowly and effectively. We are assured, for instance, that more submarines than ever are being turned out, which does not suggest much interference with production. In this connection may I ask what is the use of Flying Fortresses bombing from the sub-stratosphere? What possible accuracy could this have from such a fantastic height? I can only imagine that the demoralising effect of a bomb crashing out of the blue must be worth the effort.

As a last query, why is it that a vast works like the Skoda Arms Works, which must be a God-send to the Germans, is apparently left undisturbed? It had one or two bombings earlier on but apparently nothing since. I. L. JAMES.

JET PROPULSION OF AIRCRAFT

Rival Systems in Space

YOUR correspondent, Mr. K. W. Gatland, seems to be in a bit of a muddle. He assumes that jet propulsion in the absence of an atmosphere is not possible, but that rocket propulsion is possible.

Wherein lies the difference? If a rocket will fly through empty space, will it not be due to the reaction between (a) the body of the rocket, and (b) the gases discharged? And does not a jet-system fly through an atmosphere owing to the reaction between (A) the body of the jet-system, and (B) the gases discharged *plus the atmosphere*? Then if we eliminate *the atmosphere* from (B) is not the case exactly the same as (a)? The conclusion is that both systems are identical in principle, and if one would work, so would the other.

The problem of carrying sufficient stored energy in the form of (1) fuel and oxygen, or (2) explosives which do not require separate oxygen, is common to both.

But can it be assumed that the behaviour of a rocket *in vacuo* is the same as that of a rocket in an atmosphere? It seems obvious that the propulsive effort would be less, and dependent upon the *mass* of the gases discharged, but is it possible to assert that the discharged gases would not either (i) disperse rapidly into space, and thereby introduce an unknown factor, or (ii) surround, cling to, and be carried on with, the rocket? or (iii) behave in some other way of which our absence of experience provides no knowledge?

Granted that the propulsive effort *in vacuo* is greatly reduced, does it not follow from the same reason, i.e., the absence of an atmosphere, the tractive resistance is also reduced? Tractive resistance due to friction in a perfect vacuum might be infinitely small, and therefore speed infinitely great, with a minute propulsive effort. But gravitational fields would need the expenditure of large amounts of energy to do work against them. In addition there are possibly factors of which we have no knowledge at this stage.

Nevertheless I suggest that astronautics is the coming thing. I believe that if an organisation comprising the world's best scientists, designers and experimentalists were brought together, given adequate funds, equipment and space, and a planned programme of research, design, experiment and production were put in hand, then in ten years' time an attempt to send an expedition to the moon would be a feasible, if hazardous, undertaking. MARTIN C. FERNIE.

CONTRA-ROTATING AIRSCREWS

An Example in the Torpedo

I READ with very great interest all the various correspondence on the subject of the above, and it strikes me that there has been some rather muddled thinking about this matter. One lot of people speak of torque reaction between crankshaft and bed, and the other between the propeller and the plane. Obviously, I think the engine is quite indifferent to what happens to its shaft, provided the load is, of course, not objectionable through want of balance, and so on. Therefore, exactly the same torque reaction exists as would with one propeller.

With regard to the reaction between the propeller and the plane, I suggest that most of your correspondents seem to neglect the very earliest instance of contra-rotating propellers,

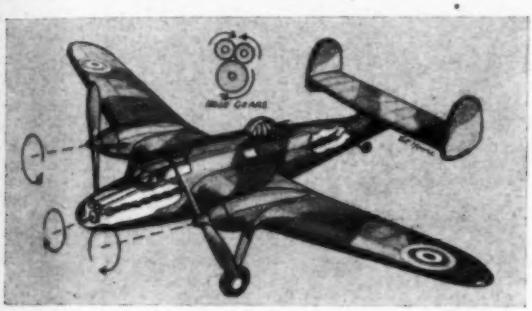
CORRESPONDENCE

which was the torpedo. Now a torpedo only has very tiny rudders, and the whole torque reaction, if there were any, would have to be taken by these small rudders, whereas in fact there is none.

I have myself made, once before the war and once since, model planes with contra-rotating propellers, and there was no torque reaction whatever. E. N. BRAY.

Demonstration by a Model

THE accompanying drawing shows a 55in. span model described in *Flight* on April 13th, 1939. Since that date it has flown several hundred times. This model has a wing loading of 11.25 oz., a speed of approximately 20 m.p.h., and an average duration of 55-60 secs. The average r.p.m. of the motor over the whole run is 1,200 to the airscrews' 1,850. It will be seen from the drawing that the contra-rotating airscrews are both driven by means of shafting and angular drives from a central power-unit shown diagrammatically.



Even when "stalled" this model sinks on an even keel and continues its original straight course. A single-screwed model, even when geared so that airscrew and rubber revolve in opposite directions, under these conditions will turn owing to torque reaction, often through 180 deg. I have built two more "twins" on similar lines to the one illustrated, and both confirm my belief that the torque reaction of the motor, when using contra-rotating airscrews, is so slight that it has no effect on a model. C. RUPERT MOORE.

Did Newton Live in Vain?

THE problem of engine torque when contra-rotating airscrews are used is causing many arguments between the two opposing schools of thought. I think the following will solve the problem.

Approaching the problem objectively let us assume that an aeroplane, which is symmetrical about the centre line, is propelled by contra-rotating airscrews designed to give equal torque reactions. The only force that these airscrews will exert on the aircraft will be the thrust. From all other sources the air loads will be symmetrical and there will be no rolling moment on the aircraft. Hence the engine cum gear-box combination, whatever form this may take, cannot possibly exert a net torque on the airframe. Remember the Third Law?—"*Action and reaction are equal and opposite.*"

Thus it is concluded that, if the gear box is integral with, or attached to, the engine, and is not mounted separately, there will be no torque reaction on the engine bearings.

I believe that those who think otherwise should find the fallacies in their arguments. Please do not let it be said that Newton lived in vain.

J. K. REDMAN, A.R.C.S., B.Sc., A.F.R.Ae.S.

Contra-rotation Correction

IN your issue of October 30th you printed a letter from me. It was written soon after I had read the first batch of letters in reply to "Mystified," whom I had missed. There must have been a misdelivery of my second letter disowning views which have now had unwelcome publicity. Thus I face an intensification of the trifling discomfiture experienced when I first appreciated my mistake.

Within a few days, and quite independently, I became fully reconciled to effective cancellation. At no time had I been convinced of the full opposite. My original line of "reasoning" suggested a halving. The contra-balance of so many experts seemed to justify this line. Defect and symptom, effect and accompaniment, all tended to confusion in theory. From all distractions there had to emerge a commonsense summary.

Other correspondents have argued from the simplest train of contra-gearing bevel, idler-bevel and return-bevel. For the benefit of non-mathematical readers the simplest train of reasoning is based on an elementary balance-bar analogy. An imaginary median slice through the idler-bevel indicates such a bar engaged with the driving and driven main bevels. From an imaginary slow manipulation of the whole outfit it will appear that, as usual, the live load on the fulcrum is the sum of both end weights or pressures.

In flight, half the engine power must go direct to the forward propeller. Half must be diverted into the gearing, and through it passed to the rear propeller. The effect of this subtracted half-power upon the idler mounting (balance-bar base) is manifestly doubled and restored to unity. In a typical case, the axial concentration of downwardly applied plus upwardly resisted loads must achieve torque cancellation.

My first tryout was a *reductio ad absurdum*. It had to be, and in fact was, abandoned. Some sentences must have seemed ambiguous without the amplifications which, like my personal qualifications, do not matter now. Nevertheless, by an odd mischance, I am entitled to introduce a fresh consideration above point-scoring. The spirit of the conclusion rightly stands, with its reference to a welcome from good into better company. I admit an undoubted mistake but, as it happens, not an unreserved one. Who will go the whole way by admitting an unreserved mistake? Beyond question, there must be several who should do so.

To a privileged few with experimental data, this whole debate may seem a waste of energy; yet every active participator must have gained some intellectual stimulation. This could prove an appreciable indirect aid to the war effort. You may yet find that you have helped to crystallise a thoroughly sound and really fundamental idea, or collection of ideas.

J. J. SNELLMAN.

Tooth Reaction of Planetary Bevels

IN your issue of October 9th, Mr. E. V. Marten-Gwilliam puts forward a mechanism which, it is claimed, will drive two similar propellers at equal speeds in opposite directions and yet leave an unbalanced torque on the aircraft.

The mechanism he shows certainly fulfils the latter condition, but it fails in its primary purpose. This is because the torque reactions of the two propellers will not be equal. It may easily be proved, by considering the tooth reactions of the planetary bevels, that the torque on the member carrying them is always greater than the torque on either of the wheels A or B (I refrain from giving this proof as, though simple, it would entail a diagram).

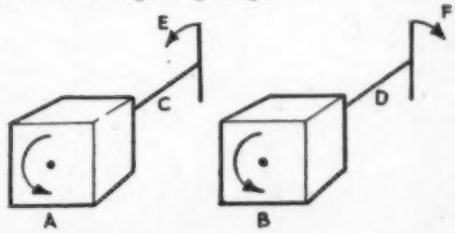
Thus it follows that the propeller driven from this member must revolve at a higher speed than the other one to make its air torque reaction greater.

Apart from general considerations, it looks as though no gear box is capable of providing balanced torque for the two propellers, unless bearing reactions arise which cancel out the torque reaction at the engine. W. M. SKENFIELD.

"Tendency to Complicate"

I HAVE been very interested in the correspondence on this subject, and though I hesitate to differ from Dr. Watt, I am wondering whether he has not in fact slipped up.

It will simplify matters a little if we regard the two props. as two distinct units with two separate engines, each of half the power of the larger single engine.



A is an engine of, say, 500 h.p., with a direct drive to its prop. E, which revolves anticlockwise. B is another engine of 500 h.p., also running anticlockwise, but having a gear box (integral with the engine) which reverses the direction of revolutions of shaft D as compared with shaft E; the prop. F therefore revolves clockwise.

Since the shaft D is revolving at the same speed and with the same torque as shaft C, but in an opposite direction, surely the real working conditions are exactly the same as in Dr. Watt's

CORRESPONDENCE

example of two engines whose crankshafts turn in opposite directions? (I neglect frictional losses in gear box.) I think there has been some tendency to complicate the issue by regarding the gear box as a separate unit and attempting to consider its reactions separately.

But if we regard the engine and gear box as being in one casing, the only point we have to consider is the reaction between the engine B and shaft D. It therefore seems to me that your contention that the torque reactions are balanced out is correct. V. G. P. WILLIAMS, M.A. (CANTAB).

Resultant Mechanical Forces

THE remarks of your correspondents interest me as representative of technical opinion on the subject.

Further to my postcard to you describing the effect on the controls of a plane with single prop or contra-props, it occurs to me that your readers may like to investigate the action of the resultant mechanical forces (distinct from aerodynamical forces) upon the airframe in flight. Obviously the gearing will be called upon to withstand two forces in opposite directions, the resultant of which will be transmitted to the engine-shaft; further, a force due to the "mis-matching" of the two props will be taken by the gearing mounting.

The resultant force will be more or less affected by any difference in weight, or aerodynamical characteristics of the clockwise or anti-clockwise rotating elements, or masses, consisting each of a prop, its shaft and gearwheel. It may possibly be found in practice that the slipstream through the front prop will have an effect upon the rear prop which may have to be so designed and constructed as to neutralise such an effect.

REGINALD DAINTY, M.S.I.E., A.Am.I.E.E., A.S.A.I.E.E., A.M.I.E.E., A.R.Ae.S.

Effect of Slipstream

SO much has been published in your magazine about contra-props that I refrained from writing to you. But as one thing seems straightened up, a new suspicion is thrown in many minds by the introduction of slipstream.

The whole thing boils down to this: Every action equals its reaction; one cannot squeeze a friend's hand without his having his hand squeezed; one cannot impress a torque on something without that thing absorbing the torque, or reacting to the torque by an opposite torque (leaving alone acceleration periods). To make a propeller rotate in the air one has to apply a torque to it. No matter how many gears or gadgets are used, what is left of the aircraft when the propeller is taken away has to apply that torque, and cannot do so unless it finds support on the surrounding air.

If two propellers are driven in opposite directions, and if it is assumed that they absorb equal torques, what is left of the aircraft when those propellers are taken away, has no torque to apply—no matter, again, how many gears are used.

This is what some of your correspondents tried to demonstrate by considering intricate gearings, and failed to prove because they forgot something—all the easier to do because their devices were so complicated.

Now about slipstream: the propeller applying a torque to the air sets it into rotary movement. This results, on single-engined machines, in a general circulation of the air round the fuselage. The effect of this circulation is two-fold.

(1) It increases the incidence on one side and decreases it on the other side, giving a torque about the longitudinal axis.

If looking from behind, the propeller is turning clockwise, the slipstream will turn clockwise and produce on the inner parts of the wing a clockwise torque. The torque applied by the aircraft to the propeller is clockwise, thus the torque applied by the air to the wing must be clockwise. And the slipstream helps thus to produce that torque without the use of ailerons. But since the effect of the slipstream and the efficiency of the ailerons vary with the speed of the aircraft, the amount of aileron deflection (or difference of rigging between port and starboard wing) required is variable with the speed.

In fact, the adjustment required is very small except in the very early stage of take-off. If it had any considerable importance the multi-engined machines would not be fitted, as they usually are, with propellers revolving in the same direction.

(2) The second effect of the slipstream is on the rudder. Since the rudder is usually in the upper part of the slipstream, it is struck by an oblique flow of air, which has a tendency to yaw the aircraft. To compensate this, one has to put the fin askew, or to apply rudder. If the propeller is revolving clockwise (from behind) the rudder will be pushed by the air to the right (yawing to the left), which has to be compensated by applying right rudder, or by offsetting the fin with the leading edge to port.

Again, the influence of the slipstream, and the efficiency of the rudder are variable with the speed, so that the deflection of the rudder has to be adjusted. It is maximum for take-off when the engine develops full power and the speed of the aircraft is low.

This effect is the *only* troublesome one, and I am afraid it is mistaken for propeller torque though it has nothing to do with that torque. It may be assumed that the slipstream resulting from two propellers revolving behind each other in opposite directions would not revolve appreciably, and that consequently the tendency to yaw would disappear (the torque having a tendency to roll the aircraft).

"PILOT OFFICER."

WAITING FOR SUNSET: Short Stirlings at their dispersal points with engine and cockpit covers on. Each machine is test flown in daylight by its crew before flying on operations.

AUTOGIRO COUNTRY: Lockheed Lightnings in a formation flight from Burbank, California, to the U.S. Army Air H.Q. in eastern America. The Allison engines of the Lightning are fitted with exhaust-driven turbo-superchargers.

Royal Air Force and Fleet Air Arm News and Announcements

Awards

THE KING has been graciously pleased to approve the following awards in recognition of gallantry displayed in flying operations against the enemy:—

BAR TO THE DISTINGUISHED FLYING CROSS.

Act. Sq. Ldr. A. S. FORBES, D.F.C., R.A.F.O., No. 66 Squadron.—This officer has participated in numerous operational sorties during the last five months. In addition to many arduous convoy patrols he has led wing formations as escort to bombers on missions over France; he has also carried out many attacks on enemy ground targets with a large measure of success.

Sqn. Ldr. Forbes has always shown the greatest keenness to engage the enemy, and has undoubtedly contributed materially to the high standard of operational efficiency of the squadron. At his own request he has been permitted to make long flights out over the sea, alone, in an endeavour to engage enemy aircraft.

Act. Sqn. Ldr. F. J. HOWELL, D.F.C., No. 118 Squadron.—This officer has displayed fine qualities as a fighter pilot, combined with outstanding leadership and talents for organisation. He has played a large part in raising and maintaining a high standard of operational efficiency in his squadron, which has greatly distinguished itself during recent operations. Throughout, Sqn. Ldr. Howell has set an excellent example. He has destroyed at least ten enemy aircraft and probably a further seven.

DISTINGUISHED FLYING CROSS.

F/O. K. C. D. DART, No. 204 Squadron.—F/O. Dart, as captain of a Sunderland aircraft, carried out an important reconnaissance from which he brought back valuable information. On the return journey his aircraft was attacked by four enemy fighters, which carried out concerted attacks for ten minutes. The first burst of fire from the leading enemy aircraft put the Sunderland's rear turret out of action, besides causing other damage and wounding three of its crew.

F/O. Dart, by skilful manœuvring, saved his aircraft from further damage and enabled his remaining guns to damage one of the fighters, which then disappeared. F/O. Dart's aircraft was then joined by another Sunderland and, between them, they shot down an enemy fighter into the sea. F/O. Dart has continuously displayed exemplary courage, coolness and skill in action.

F/O. P. I. HOWARD-WILLIAMS, No. 118 Squadron.—This officer has participated in 24 operational sorties, including attacks on shipping and targets on the enemy occupied coastline of France. In the course of these operations he has been responsible for the sinking of one armed ship and damaging several others.

In addition, he has attacked enemy wireless stations and a number of anti-aircraft posts, inflicting heavy damage. He has displayed exceptional keenness, and, on many occasions, has obtained information which has proved of great value. He has destroyed two enemy aircraft and has set a splendid example of coolness, resource and fearlessness.

A 17in. diameter stained glass plaque of a Westland Lysander executed by Mr. Leonard Walker, R.I., for his son, Flying Officer R. M. Walker, who is now an instructor in Rhodesia. Flying Officer Walker flew a Lysander during the battle of France.

P/O. D. FULFORD, R.A.F.V.R., No. 118 Squadron.—This officer has participated in a number of operational sorties. During these operations he has been responsible for damaging enemy wireless stations and anti-aircraft posts; he has also damaged a number of ships. P/O. Fulford has displayed courage and keenness, and has destroyed two enemy aircraft and assisted in the destruction of a further two.

DISTINGUISHED FLYING MEDAL.

Sgt. D. C. MARTIN, R.C.A.F., No. 42 Squadron.—Sgt. Martin has participated in 23 operational missions. In October, 1941, he was the observer of a Beaufort aircraft which carried out an attack at dusk on enemy shipping off the Norwegian coast.

A successful attack was carried out but in the heavy gunfire encountered Sgt. Martin was wounded in the leg. He did not inform the pilot of his injuries, however, and successfully navigated the aircraft back to base without the aid of the air speed indicator, which had been put out of action.

This airman's courage in navigating the aircraft under difficult conditions, and in spite of pain from his wounds, has set a magnificent example.

THE KING has been graciously pleased to approve the undermentioned award in recognition of gallant conduct:—

BRITISH EMPIRE MEDAL (MILITARY DIVISION).

Sgt. D. C. A. WILKINSON.—One night in June, 1941, this airman was the wireless operator of an aircraft which, in the course of an operation, was compelled to descend on to the sea off the Dutch coast. Although Sgt. Wilkinson had had trouble with his wireless set he had managed to maintain wireless contact with a home station until the aircraft crashed, thus enabling an accurate fix to be obtained of the aircraft's position. After the crash he released his captain, who was strapped in and assisted him through the front top hatch. Sgt. Wilkinson was about to leave the aircraft, which by this time was half full of water, when he observed the navigator lying unconscious in the tunnel. Sgt. Wilkinson immediately went to the navigator's assistance, and dragging him into the cockpit, managed to revive him and then assisted him to climb out through the top hatch.

Following him through the hatch, Sgt. Wilkinson saw the dinghy had not yet been launched so, dropping down on to the port wing, he jumped into the sea, swam round to the door and, open-

TRAINER FORMATION IN CANADA. The Tiger Moth in its new guise with enclosed cockpit, is doing excellent work in Canada under the Empire Training Scheme. Temperature being low at this period the extra protection is appreciated. A flight of E.F.T.S. Tigers operated over the prairie land of Saskatchewan is the subject of this illustration.

ing it fully, enabled the rear gunner to throw out the dinghy. It failed to open, but Sgt. Wilkinson pulled on the cord until it eventually opened, but upside down. Finally, however, the dinghy was righted and all the crew were able to jump into it except the navigator, who fell in the water. Sergeant Wilkinson grasped him and with the assistance of the rear gunner was able to pull the navigator into the dinghy. Within the next few minutes the aircraft sank.

Sgt. Wilkinson showed great presence of mind and devotion to duty and undoubtedly was instrumental in saving the life of the navigator, besides contributing largely to the successful launching of the dinghy, which led to the eventual rescue of the entire crew.

Roll of Honour

Casualty Communiqué No. 83.

THE Air Ministry regret to announce the following casualties on various dates. The next-of-kin have been informed

Royal Air Force

KILLED IN ACTION (WHILE FLYING IN OPERATIONS AGAINST THE ENEMY).—Sgt. R. F. Abernethy; Sgt. G. E. Boxall; Sgt. R. W. C. Clark; Sgt. E. S. Cox; P/O. G. S. Eccles; P/O. D. I. Evans; Sgt. D. H. Hodge; Sgt J. H. Ixer; P/O A. A. Law; Sgt. R Leagas; Sgt. E. G. B. Lennon; Sgt. D. R. Mallett; Sgt. J. R. Newcombe; Sgt. D. A. J. Paine; Sgt. E. B Parker; Sgt. E. G. Paul; Sgt. A. H. Rex; Sgt. F. D. Rogers; P/O. A. G. Stanes; Sgt. C. O. Steggall; Sgt. J. Tankard; Sgt. N. P. Van Der Merwe; Sgt. A. A. Watt; Sgt. A. D. Wimbush; Sgt. A. J. Witherington.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. H. D. Bowles; P/O B. A. Childs; Sgt. J. J. H. Deacon; Sgt. L. Flint; F/O. J. K. Flynn; F/O. J. H. Y. Foxton; Sgt. C. E. Gansler; Flt. Lt. D. Gibson; P/O. W. C. Hall; Sgt. J. H. Kelly; P/O. D. F. Knight; Sgt. G. Maclean; F/O. L. E. Pearson; P/O. J. J. Robinson; Sgt. R. T. Selley; Sgt R. A. Stephens; Sgt. S. A. Taylor; P/O. R. H. Vaughan; Flt. Lt. G. Watson.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. A. J. Arnott; P/O. J. D. Chandler; Sgt. G. Cuthbert; Sgt. K. Dalton; Sgt. H. T. H. Downes; Sgt. C. R. Evans; P/O. J. M. Fothergill; Sgt. P. Gibbs; Sgt. E. H. Harvey; Sgt. G. W. Hickman; P/O. A. L. Jones; Sgt. C. H. King; Sgt. W. Lake; Sgt. R. G. Lambourne; P/O. R. C. Lawson; Sgt. G. S. M. MacLeod; P/O. M. A. G. Mason; Sgt. J. R. Miller; P/O. K. M. Millist; Sgt. R. F. Murphy; P/O. G. R. H. Newton; Sgt. J. A Norris; Sgt. P. R. Parker; Sgt. R. Ridgman Parsons; Sgt. J. Riley; P/O. R. Smith; P/O. M. L. Stedman; Sgt. F. H. Sykes; Sgt. R. H Thomas; Sgt. J. Wallace; P/O. J. R. Waterman; Sgt. C. Whitehill.

WOUNDED OR INJURED IN ACTION.—Sgt. W. J Batchelor; Sgt. R. W. Egleton; P/O. F. A Rabagliati; P/O. A. S. Raphael; P/O. J. M Robertson; P/O. W. B. Sanders; Sgt. J. S. Sutton.

DIED OF WOUNDS OR INJURIES RECEIVED IN ACTION.—P/O. B Bartholomew; F/O. B. W Jeffery; P/O. L. R. Marshall; Flt. Sgt. B. C Woolbridge, D.F.M.

MISSING, BELIEVED KILLED IN ACTION.—P/O J. F. Ashton; Sgt. J A Brooks; Sgt. A. A. Cormack; Sgt. H. M. Elder; Sgt. E. Halestrap; Sgt. A H Higgs; Flt. Sgt. E. F. Howarth; Sgt. R R Hutt; Sgt. J. E. Jerrard; Sgt. B. T. Kearsley; P/O. J. E. King; Sgt. G. Klusky; Sgt. N. J Lake; Sgt. E. R. V. Lane; Sgt. K. Morris; Sgt. G. W. Richardson; P/O. J. H. Rodgers; Sgt. R. D. Starkie-Bence; Sgt. J. J. Stritch; Sgt. F. W. Taylor; Sgt. C. A. Tracey; Sgt. L. A. Warburton; Sgt. J. H. Williamson.

MISSING.—P/O. J. O. Alexander; Sgt. R. Allan; Sgt. R. F. Archer; Sgt. W. R. Balls; Sgt. R. A. Banks; Sgt. J. W Bills; Flt. Sgt. J. L. Briggs; Sgt. S. D. Chamberlain; Sgt. G. A. Cook; Sgt. G. A. V. Cope; P/O. R. Le M. Cox; Sgt. J. Crocombe; P/O. K. W. Davies; Sgt. N. H. Davies; Sgt. E. G. R. Drobig; Sgt. J. R. Durber; P/O. H. J. A. Dyer, D.F.M.; Sgt. J. T. Evans; Sgt. G. W Fenton; Sgt. V. Flynne; Sgt. C. A. Foster; Sgt. I. P. McH. Gordon; P/O. S. Goulston; P/O E. J. D. Guild; Sgt. A. J. Hardy; Sgt. G. T. Harper; Sgt. E. C. Hatton; P/O. F. J. Hogan, D.F.C.; Sgt. C. D. James; Sgt. T. H. B. Jones; Sgt. J. H. Joy; Sgt. W. B. Low; Sgt. A. Macdonald; Sgt. D. McTavish; Act. Sqn. Ldr. A. Mathieson; P/O. D. P. F. C. Mauchlen; Sgt. A. Needham; Sgt. G. J. Parkin; Sgt. H. J. Phillips; Sgt. T. P. Riddell; Sgt. L. A. Robertson; Sgt. J. C. Saich, D.F.M.; Sgt. J. G. Selley; Sgt. H. D. P. Sleath; Flt. Lt. D. Stewart-Clark; Sgt. E. Trott; St. W. E. Tulley; Sgt. H. B. Turner; Sgt. H. N. Unwin; Sgt. G. Waddilove; Sgt. A. D. Wallace; Sgt. R. Willis.

MISSING, BELIEVED KILLED ON ACTIVE SERVICE (WHILE ENGAGED ON NON-OPERATIONAL FLYING DUTIES OR ON THE GROUND THROUGH ENEMY ACTION).—L.A/C P. Bond.

KILLED ON ACTIVE SERVICE.—P/O. S. H. Birtles; A/C.1 W. T. Bourne; A/C.1 R. Boyd; F/O. D. C. Carleton; L.A/C. L. W. Carter; Act. Sqn. Ldr. A. J. F. Churchill; L.A/C. D. Colquhoun; Sgt. F. G. Coster; F/O. E. E. G. Crump; P/O. A. M. De La P. Disney; Flt. Sgt. B. Elms; A/C.2 J. W. Grace; Sgt. J. W. R. Griffiths; P/O. R. F. Keighley; Sgt. A. C. Letham; A/C.2 J. Lister; A/C.2 C Mair; Sgt. N. A. Mathison; P/O. H. I. Millar; P/O. J. E. Millns; Sgt. G. Newman; L.A/C. P. H. A. Pickering; Act. Sqn. Ldr. J. D. Reardon; L.A/C. J. F. Riding; Sgt. T. R. F J. Roch; L.A/C. J. V. W. Shand-Kydd; A/C.2 F. A. Sullivan; P/O. J. R. Thomson; Act. Flt. Lt. A. F. Vokes; F/O. J. S. Willis; L.A/C. H. Winter.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW PRESUMED KILLED ON ACTIVE SERVICE.—P/O. L. E. Brennan.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW REPORTED KILLED ON ACTIVE SERVICE.—L.A/C. R. Daly; Sqn. Ldr. W. J. Methven.

WOUNDED OR INJURED ON ACTIVE SERVICE.—Sgt. H. Maple; Sgt. T. C. Roux; A/C.1 H. G. A. Snelling.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—Sgt. S. V. Beaumont; A/C.2 E. G. Gasson; Sgt. H. G. Lintott; P/O. A. R. Riefstahl.

DIED ON ACTIVE SERVICE.—A/C.1 J. W. Bell; A/C.1 W. P. Collins; L.A/C. E. L. Mess; Cpl. C. Naylor; L.A/C. D. Walters.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—P/O. J. W. Best; P/O. N. C. Downie; F/O. C. A. S. Greenhill, D.F.C.; P/O. E. C. Maskell.

Royal Australian Air Force

MISSING, BELIEVED KILLED IN ACTION.—P/O. R. M. Hamilton.

MISSING.—P/O. W. D. Willis.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—P/O. J. P. McKechnie.

Royal Canadian Air Force

KILLED IN ACTION.—Sgt. F. A. B. Brodribb; Sgt. D. C. Chattell; P/O. W. R. Lugar; Sgt. G. E. Proctor; Sgt. W. H. Trewin; Sgt. R. L. Ward; Sgt. H. D. Weaver.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. G. J. Mayor.

DIED OF WOUNDS OR INJURIES RECEIVED IN ACTION.—Sgt. J. W. Boyce.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. E. W. Foxlee; Sgt. J. B. Redden.

MISSING.—Sgt. J. M. Dixon; Sgt. J. G. Keating; Sgt. M. McL. Keswick; Sgt. W. C. Mackenzie; Sgt. W. R. Malkemus; Sgt. S. E. Rowed; Sgt. L. H. Sinclair; Sgt. F. C. Snead; Sgt. L. G. Spilsbury; Sgt. B. G. Wilbee.

KILLED ON ACTIVE SERVICE.—P/O. J. R. Clements; Sgt. H E. Moore; P/O. J. P. A. Sawyer; P/O. W. O. Wallace.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW PRESUMED KILLED ON ACTIVE SERVICE.—Sgt. S. T. McNeil; Sgt. H. G. Peel

WOUNDED OR INJURED ON ACTIVE SERVICE.—Sgt. T. K. Wotherspoon.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—P/O. K. H. Anthony.

General de Gaulle chatting with French fighter pilots who, it is proposed, will shortly form a squadron of their own. The machine in the background is a cannon-armed Hurricane II.

...ATION

Royal New Zealand Air Force

PREVIOUSLY REPORTED MISSING BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. G. R. Wilson; P/O. R. G. Eccles.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. S. Glazer.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. B. A. Clark.

MISSING.—Sgt. F. A. Baty; Sgt. P. Gennon; Sgt. C. S. V. Goodwin; Sgt. S. G. Shirley-Thomson.

KILLED ON ACTIVE SERVICE.—Sgt. I. M. Cheyne P/O. J. F. Hunt.

South African Air Force

WOUNDED OR INJURED IN ACTION.—Air Sgt. H. E. Wiggill.

DIED ON ACTIVE SERVICE.—L.A/C. A. B. Bronstein.

Casualty Communique No. 89.

Royal Air Force

KILLED IN ACTION (WHILE FLYING IN OPERATIONS AGAINST THE ENEMY).—Flt. Sgt. J. Barry; Sgt. C. E. Bloor; Sgt. S. A. Cameron; Sgt. V. L. Carine; Sgt. L. R. Cox; Sgt. L. W. J. McCabe; Flt. Sgt. D. J. Smith; Sgt. E. C. W. Turner.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. J. F. O'Hara; Sgt. D. F. Ross; Sgt. D. C. Rowland; Sgt. H. R. Rundle.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—F/O. F. M. Boycott; Sgt. R. C. Brockway; Sgt. R. Brown; Sgt. C. M. Calder; Sgt. J. P. Cusworth; Sgt. G. L. Elliott; Sgt. H. W. Green; Sgt. C. M. F. Hitchcock; Sgt. A. J. McHardy; Sgt. T. R. McWalter; Sgt. R. H. S. Maton; P/O. D. A. Maxwell; Sgt. G. W. R. Nesbitt; P/O. R. E. Owen; Sgt. G. R. Pike; F/O. D. K. Plumb; P/O. S. A. Taylor; Sgt. A. W. White.

WOUNDED OR INJURED IN ACTION.—P/O. E. G. Brettell; Sgt. J. Endersby; Sgt. C. E. Musgrave; Sgt. C. B. Rowbotham; P/O. L. W. C. White.

MISSING, BELIEVED KILLED IN ACTION.—Flt. Sgt. L. M. Barnett; Act. Sqn. Ldr. H. E. Bulton; P/O. I. C. Burke; Sgt. A. Carstairs; Sgt. W. F. Crampton; Sgt. B. Gray, D.F.M.; Sgt. R. W. Gray; Sgt. T. G. Lister; Sgt. D. J. Mackintosh; Sgt. W. Meadows; Sgt. J. E. Pearson; Sgt. K. B. Read; Act. Wing Cdr. D. W. Scivier; Sgt. C. A. F. Thomas; F/O. T. Wardhaugh.

PREVIOUSLY REPORTED PRISONER OF WAR, NOW REPORTED MISSING, BELIEVED KILLED IN ACTION.—Sgt. R. T. Ainsworth.

MISSING.—Sgt. B. Akrigg; Sqn. Ldr. J. C. Atkins; Act. Flt. Lt. R. G. A. Barclay, D.F.C.; Sgt. G. K. Bartlett; Sgt. D. A. Bartrip; Sgt. J. G. Bell; Sgt. P. H. Bell; Sgt. P. M. Bennett; Sgt. L. Black; Sgt. F. B. Brandwood; Sgt. W. M. Brown; Sgt. J. C. V. Colmer; Sgt. B. H. Dennis; Sgt. D. F. Dunlop; Sgt. D. J. Farrell; Sgt. J. Gill; Cpl. D. M. Grant; Sgt. P. T. Grisdale; Sgt. K. J. Hasne; Sgt. C. Hambleton; P/O. C. J. Harper; Sgt. E. Healy; Sgt. A. R. Hedger; Sgt. K. F. Hood; P/O. J. C. Howell; Sgt. J. Hughes; P/O. W. E. Law; P/O. T. P. McGerty; Sgt. M. W. S. McVety; Act. Flt. Lt. R. H. May; Sgt. A. G. Mee; Sgt. J. Miller; Sgt. E. D. Minshall; Sgt. Q. E. Mortimor; Act. Flt. Lt. M. H. R. Namias; Act. Flt. Lt. R. E. Orchard; Act. Sqn. Ldr. N. Orton, D.F.C.; Sgt. D. V. Osborne; Sgt. R. A. Overson; F/O. C. D. Owen; P/O. J. B. Patterson; P/O. D. L. Petrie; Act. Flt. Lt. L. S. Pilkington, D.F.M.; Sgt. R. C. Plaistowe; Sgt. L. W. Price, Sgt. D. J. Reid; Sgt. F. E. Richardson; Sgt. J. J. Robson; Sgt. K. V. D. Roe; Sgt. G. S. Rye; Sgt. R. B. Scott; Sgt. G. L. Solman; Sgt. A. J. Somerville-Woodiwiss; Sgt. C. J. Squibb; Sgt. E. J. Start; Sgt. M. A. Stratton; Sgt. P. Thacker; Sgt. R. C. Thompson; P/O. A. R. Tidman; Sgt. K. A. Tomlinson; Flt. Lt. P. Tomlinson; Sgt. L. Trevor; A/C.1 A. Vernall; Sgt. A. W. Vernon; Sgt. C. E. Wagon; Act. Sqn. Ldr. T. J. S. Warren, D.F.C.; Act. F/O. J. T. Waterfall; Sgt. R. H. Wharton; Sgt. T. Wood.

PREVIOUSLY REPORTED PRISONER OF WAR, NOW REPORTED MISSING.—Sgt. R. J. Baghurst.

MISSING BELIEVED KILLED ON ACTIVE SERVICE (WHILE ENGAGED ON NON-OPERATIONAL FLYING DUTIES OR ON THE GROUND THROUGH ENEMY ACTION).—P/O. E. H. Burton; Sgt. D. H. Farley; Sgt. W. F. Jeffery; Sgt. F. I. Russell; Sgt. J. B. Slack.

KILLED ON ACTIVE SERVICE.—Sgt. D. H. Bartlett; Sgt. E. Bloor; Flt. Lt. C. Bowen Davies; Sgt. E. J. Braund; Flt. Lt. G. Bremridge, A.F.C.; F/O. D. F. Brooks; Sgt. E. F. Chamberlain; Sgt. S. S. J. Collier; Sgt. R. Donaldson; Sgt. P. C. Edwards; Sgt. R. D. Emery; Act. Flt. Lt. W. D. Evans; Sgt. D. G. Forbes; Sgt. H. C. Fox; Sgt. H. R. Harvey; L.A/C. A. R. Herbert; P/O. P. G. Herrick; P/O. A. A. Horne; Sgt. W. W. Hyman; Sgt. D. C. Johnston; L.A/C. B. W. Lavan; Sgt. A. J. Lipscombe; L.A/C. H. Macleod; Sgt. S. E. Miller; L.A/C. W. Moore; Cpl. A. G. F. Moye; Sgt. A. P. Overal, D.F.M.; P/O. P. R. Owen; A/C.1 S. J. Oxley; A/C.2 F. B. Prest; P/O. K. J. A. Sale; F/O. M. F. Scragg; Sgt. D. G. K. Smith; Sgt. H. R. Tuff; Sgt. A. L. Walker; Sgt. J. G. Walters; Cpl. N. West; Sgt. T. I. A. West; Sgt. J. S. M. Worton.

WOUNDED OR INJURED ON ACTIVE SERVICE.—A/C.1 J. L. Favell; Sgt. C. Hall; Sgt. R. G. Henderson; Sgt. E. J. Rawsthorne; Sgt. W. A. Rowe; Sgt. A. R. L. Tacq.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—P/O. J. W. Goodchild; A/C.1 G. S. Hilton; Sgt. A. R. Patrick; Sgt. H. G. Tasker.

DIED ON ACTIVE SERVICE.—A/C.2 H. W. Bagaley; F/O. B. Beach; A/C.1 J. Bond; A/C.1 H. Bucknell; P/O. G. L. Coats; A/C.1 W. E. Donovan; A/C.2 W. C. Dorrington; A/C.1 R. S. Dutton; A/C.2 H. Fairhurst; Sgt. F. Harker; F/O. C. A. Langton; L.A/C. J. McKeever; Sgt. J. Mackinnon; A/C.2 C. Mason; Cpl. G. W. Pollard; Act. Flt. Lt. J. K. Rodger; Flt. Sgt. G. A. Wickham.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—Act. Flt. Lt. R. B. Barr; Sgt. G. M. Kerr; Sqn. Ldr. B. G. Morris; Sgt. J. E. Wiggall.

Royal Australian Air Force

KILLED IN ACTION.—Sgt. C. J. Corley.

WOUNDED OR INJURED IN ACTION.—F/O. J. S. Stratton.

MISSING.—P/O. B. E. Hislop; Sgt. C. F. R. Manning; P/O. R. M. Ryder; Sgt. N. Tweedie.

KILLED ON ACTIVE SERVICE.—P/O. R. Feilden.

Royal Canadian Air Force

KILLED IN ACTION.—Sgt. W. R. Finlay.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. D. S. Craib; Sgt. R. A. Reid.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. J. M. Nickelson.

MISSING.—Sgt. G. R. Blackmore; Sgt. C. J. Brakeman; P/O. R. M. Burlinson; Sgt. J. D. Draper; Sgt. T. B. Hopkins; Sgt. C. L. MacDonald; Sgt. J. J. McIntyre; Sgt. J. P. McKay; Sgt. J. B. Robertson.

KILLED ON ACTIVE SERVICE.—P/O. F. B. Brown; P/O. D. D. Christie.

WOUNDED OR INJURED ON ACTIVE SERVICE.—Sgt. T. F. Heron.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—Sgt. M. B. D. Delaney; P/O. M. H. Gifford; P/O. W. M. Mackay.

Royal New Zealand Air Force

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. R. W. Finlayson.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. J. C. Cattell.

WOUNDED OR INJURED IN ACTION.—Sgt. C. A. F. Marunich.

MISSING.—Sgt. D. L. Rhodes.

KILLED ON ACTIVE SERVICE.—Sgt. W. Brownlie; Sgt. N. A. J. Clifford; Sgt. L. J. Ellmers; Sgt. J. Fyvie; Sgt. V. H. Griffiths; Sgt. J. E. Wall.

South African Air Force

KILLED ON ACTIVE SERVICE.—Air Sgt. A. V. Hunt; Air Sgt. B. Mede-Marillac.

WOUNDED OR INJURED ON ACTIVE SERVICE.—A/M. V. C. Geale; 2/Lt. M. Macrobert.

DIED ON ACTIVE SERVICE.—L.A/C. J. K. Haytera.

Indian Air Force

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—P/O. Rao Cherala Raghava.

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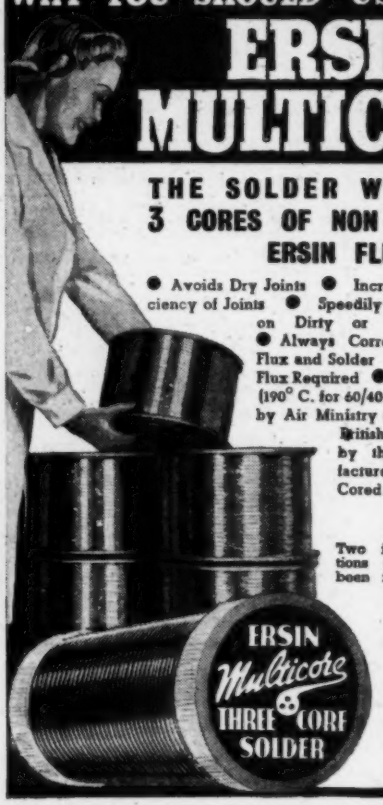

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